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The Need of Improved Machinery for Terrace Construction and Farming Terraced Land[1]

By C. E. Ramser[2]

C. E. Ramser

IT IS estimated that erosion removes not less than 126 billions of pounds of plant food material from the fields and pastures of the United States every year. This is more than twenty-one times the annual net loss removed by crops according to an estimate of the National Industrial Conference Board. A rough estimate places this loss to the farmers of the United States at about $200,000,000 annually. So serious is the situation that N. S. Shaler, formerly dean of the Lawrence Scientific School, was once moved to remark that, if mankind cannot devise and enforce ways of dealing with the earth which will preserve this source of life, "we must look forward to the time—remote it may be, yet clearly discernible—when our kind, having wasted its greatest inheritance, will fade from the earth because of the ruin it has accomplished."

Erosion injures or practically ruins fertile lands in a number of ways. The upper and most fertile parts of the soil are washed away until the land becomes barren and unproductive. Deep gullies are formed which mean an actual loss of cultivable land area, and cause a lowering of the water table and a deficient supply of moisture. (Fig. 2) Drainage ditches often become filled with sand, which frequently results in the flooding of the adjoining bottom land and the destruction of crops. Rich bottom lands often are covered by deposits of sand washed from the hill lands. Hence the direct erosion losses of the upland farmer are the loss of the land occupied by gullies, smaller crop yields each year, and continued decrease in the market value of the land. Some of the losses suffered by the bottom land farmer are cultivable land covered with sand, crops damaged by overflows or deposits of sand, continued decrease in the market value of the land and the money invested in the construction of drainage ditches that have been wholly or partly filled with sand. Thus it is apparent that both the bottom land farmer and the upland farmer should be vitally concerned in effective measures of checking erosion.

Erosion is caused chiefly by the direct action of heavy rains beating upon the ground; by the rapid movement of the rain water down the slopes of the land surface; and by the combined action of the freezing and thawing of a saturated soil, followed by heavy rains. If most of the rain water penetrated the ground upon which it falls, erosion would be greatly reduced. It is obvious, therefore, that in order to prevent or reduce erosive action, the soil must receive treatment that is conducive to the admission and the storage of large quantities of rain water, and methods must be employed to reduce the velocity and thereby the transporting and erosive power of the run-off water.

Since the storage capacity of the soil depends upon its porosity, any treatment which results in an increased porosity of the soil will reduce erosion materially. This porous condition can usually be obtained by deep plowing and the thorough incorporation of organic matter in the soil. The treatment of cover such as seeding land to meadow or pasture, growing timber and planting cover crops tend to check and diminish erosion. Other methods which retard the flow of the water and conduct the excessive run-off from the field with a reduced amount

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December 1930.

[2]Senior drainage engineer, U. S. Department of Agriculture. Mem. A.S.A.E.

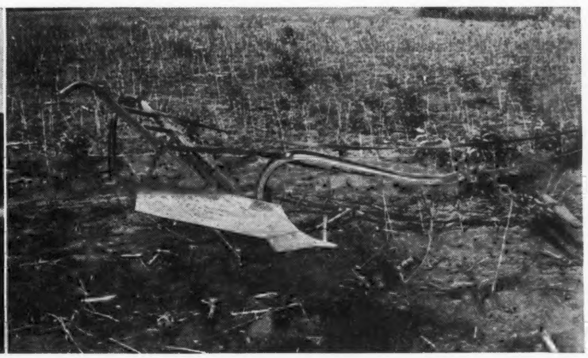


Fig. 1. (Left) This shows water standing above a circle level Mangum terrace with no outlet. Fig. 2. (Right) Terracing plow with special moldboard used for building terraces


Fig. 3. (Left) A homemade wooden "V" drag widely used in building terraces. Fig. 4. (Right) A V-shaped ditcher also used as a terracer

of erosion are subsoiling, contour farming, and terracing. Terracing is generally regarded as being the most dependable and effective method of stopping erosion and is doubly effective when employed in conjunction with some of the methods mentioned above.

EARLY PRACTICE

According to the earliest practice, terracing consisted of building up the surface of the land in a series of level areas resembling stair steps. This type of terrace has long been used extensively in Europe, Asia and South America and is still being used to a considerable extent on the steeper lands in the southeastern part of the United States. It is known generally as the bench terrace. Strictly speaking it is the only true terrace, but the word "terrace" in this country is applied also to ridges of soil thrown up and located in such a manner as to prevent the rapid flow of water down the slope and the entire ridge is cultivated.

The bench terrace has never become popular with the farmer because of the difficulty of moving farm machinery from one bench to another; the necessity of cultivating each bench separately; the loss of land occupied by the uncultivated embankment; and the growth of weeds and grass on the embankment, which robs the adjacent cultivated soil of its plant food and tends to seed the entire field to weeds and objectionable grasses.

Since the introduction of the broad-base ridge terrace which can be cultivated, the bench terrace is rapidly disappearing on all lands of moderate slope. This terrace is generally known as the Mangum terrace and was originated and developed by P. H. Mangum about 45 years ago on his farm near Wake Forest, North Carolina. These terraces are usually built from 15 to 30 feet wide at the base and from 15 to 24 inches high. The entire but that of July 25, 1928, was typical. The air temperature terrace is cultivated leaving no waste land in the field. The original Mangum terrace was built with fall along the terrace to carry off the run-off water in a broad, shallow channel at a low non-eroding velocity. This terrace is sometimes laid out level, and all of the rain water that falls on the slope between the terraces is collected and retained in the channel of the lower terrace until it evaporates, percolates into the soil or finds its way slowly to an outlet at the end of the terrace (Fig. 1).

Terracing was first extensively practiced in the southeastern states. Since about 1915 the practice of terracing has been coming rapidly into favor in states west of the Mississippi River, and today perhaps the best terracing methods are employed in the states of Oklahoma and Texas. That terracing is regarded as important and essential to the maintenance of land values in Texas and Louisiana is exemplified by the fact that the Federal Land Banks of Houston and New Orleans require the terracing of land subject to soil washing before granting loans.

It is reported by the Office of Cooperative Extension Work of the U. S. Department of Agriculture that during the year 1929 terracing work was done in 27 states. The states leading in this work were Texas, Alabama and Georgia where 630,000, 296,000 and 219,000 acres of land, respectively, were terraced. In all about 3,600,000 acres of land have been terraced in Texas. Of the 36,000,000 acres of farm land in Oklahoma, G. E. Martin, formerly state extension agricultural engineer, estimates that 90 per cent of it can be benefitted by terracing from the standpoint of soil erosion or moisture conservation. Experience with terraces indicates that there is a need for research and experimentation to determine more definitely the best design and methods of construction of terraces under different farming methods and for different soils and land slopes, and perhaps the most outstanding problem in this research field is that of developing suitable machinery both for the construction of terraces and for farming terraced land. Farmers are primarily interested in seeing machinery developed that will reduce the construction cost of terraces. They are likewise vitally interested in machinery designed to operate successfully in terraced fields with facility, at a low cost and with a minimum of injury to the terraces.

IMPLEMENTS FOR TERRACING

Many different implements are used in the construction of terraces. The simplest implement used is the ordinary plow, and it is used quite effectively on moderate slopes, the principal difficulty being to build terraces sufficiently high. Some plows are equipped with special moldboards or an extra wing to assist in throwing the soil higher. (Fig. 2). Disk plows and disk harrows are also quite commonly employed in building terraces especially on moderate slopes. Usually more than one plowing or disking is required to obtain the desired terrace height.

A simple homemade implement which has been widely used in the construction of terraces is the wooden "V" drag (Fig. 3). In using the "V" drag the dirt is usually loosened with a plow and the drag follows in the plow furrow. The chief advantage of the wooden drag is its cheapness. Considerable time and labor are required to build a satisfactory terrace with a "V" drag as compared with the steel "V" ditcher shown in Fig. 4. As in the case of the "V" drag this implement operates more satisfactorily in most soils when it follows a plow. This machine has enjoyed a wide reputation as an effective terracing implement. It has demonstrated its value as being especially effective for terracing land where rocks, roots and stumps are encountered, and is not as easily damaged where such conditions prevail

as the terracing implements of the grader type. This implement has an adjustable blade which can quickly be adjusted to meet varying conditions of soil or other requirements in terrace building. It does not require a plow and has the advantage of being quickly reversed at the end of a field where all or most of a terrace is built by moving the dirt from one side. These implements are built in several sizes for horses or tractor power and require less power than the more expensive road grader, which is used quite extensively in building terraces. In addition to requiring considerable power the road grader has the disadvantage of requiring more time to turn at the end of a terrace and thus greatly increases the cost of short terraces. It is also difficult to operate satisfactorily in crossing gullies.

An intensive study leading to the design of improvements in terracing machinery that will answer the needs of the individual farmer with limited power and of the contractor with large power units that will build a satisfactory terrace in fewer rounds and at a less cost is amply warranted in view of the rapidly expanding terracing program now in progress in this country. During the year 1929, about 2 500 000 acres of land were terraced in the United States. If the cost of terracing this land could have been reduced only 25 cents an acre a saving of $625,000 to the farmers would have resulted. J. C. Wooley, agricultural engineer of the University of Missouri, is on the program to discuss new machinery for terracing work and especially a terracing machine that he has been developing. I am informed that L. E. Hazen, agricultural engineer of the Oklahoma A. and M. College, is also working on a new machine of the elevator type designed to reduce the power required to move the dirt, and I believe that it will be a question of only a short time when new machinery will be developed that will satisfactorily meet the growing demand for cheaper terraces.

MACHINERY FOR FARMING TERRACES

Coincident with the need for the development of new machinery to construct terraces is that of the modification in the design of existing farm machinery to operate more successfully in terraced fields. In connection with this problem a study should be made of the most satisfactory cross-section of a terrace on different slopes from the standpoint of the successful operation of prevailing types of machinery now used in any particular farming section. A cross-section of a terrace that would be satisfactory for such machinery as is used in the cotton belt would not necessarily be satisfactory in the western wheat belt where large power machinery prevails. Also a preliminary study shows that it is impossible to adopt any one cross-section in a particular locality that will satisfy equally well the requirements of the different kinds of machinery such as binders, planters, cultivators, etc., now in use. From this it appears that a modification in the design—perhaps slight in many instances—would be required in existing machinery to meet the requirements for satisfactory operation for any adopted terrace cross-section.

Another important factor in this problem is the method employed in farming the terraces. Two methods are quite commonly practiced; that of conducting all farm operations parallel to the terraces (Fig. 5) and that of crossing the terraces at any angle with farm machinery (Fig. 6). Where the former method is employed more time is required and inconvenience experienced in farm operations, but less erosion occurs and less work is required in maintaining the terraces to the desired height. The practice of farming parallel to the terraces is rapidly increasing particularly where row crops such as cotton and corn are planted. The other practice of farming across the terraces is quite generally practiced especially in wheat-farming regions where large power machinery is employed. More flexible machinery is required where farm operations are conducted across than where parallel to the terraces.

USE OF TRACTORS OVER TERRACES

On the soil erosion experimental farm, at Hays, Kansas, a comparison was made of tractors of the wheel and tracklaying types in wheat farming on moderate slopes. It was found from the standpoint of traction particularly in crossing the comparatively loose soil in the tops of the terraces that the tracklaying type tractor had considerable advantage. The wheel tractor could not readily cross the terraces with the same load that it could easily handle between the terraces and much time was lost due to digging in and stalling in crossing a terrace, also resulting in considerable injury to the terrace. This was found to be especially true for newly built terraces. About the only disadvantage of the tracklaying type tractor is the shock received by the tractor and operator when the tractor moves up one side of a terrace and drops down on the other side.

Considerable attention has been given during the last two years to the operation of general-purpose tractors in terraced fields particularly in the cultivation of crops. Two outstanding criticisms are the lack of self-stabilization, which results in a tendency to creep when working on a side of a terrace, and lack of flexibility in both the longitudinal and lateral planes of the cultivator. The tendency to creep or slip down the slope often results in plowing out or covering the crop. Lack of the proper flexibility is responsible for the shovels digging in excessively deep when crossing a terrace, which often results in plowing out the crop row on top of the terrace. Less digging occurs where the location of the cultivator gangs is such that they rise and fall with the wheels of the tractor in crossing a terrace. It seems that depth of plowing might be satisfactorily regulated by the use of gage wheels at each gang of sufficient size and width to lift the gangs in loose soil conditions. Apparently general-purpose tractors have been designed to operate on level ground where they do a perfect job. It is believed, how-

Fig. 5. (Left) In this field the grain is drilled parallel to the terraces. Fig. 6. (Right) Crop rows running across a terrace

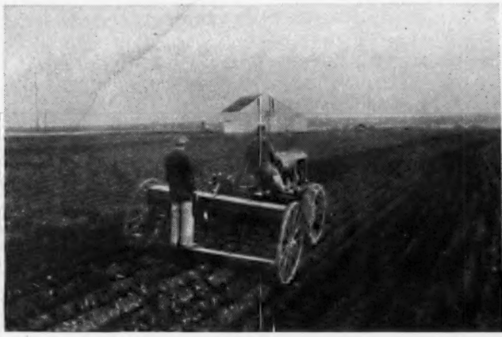



Fig. 7. (Left) Drilling oats with a 7-foot deep-furrow drill on the lower side of and parallel to a terrace, having a 20-foot base width and 15-inch height. Fig. 8. (Right) This drilling outfit is crossing a terrace at right angles; the field has a comparatively flat slope of from 1 to 2 per cent

ever, that a satisfactory degree of stabilization and flexibility can readily be obtained by simple changes in design which are necessary if the two-row tractor cultivator is to play a prominent part in the farming of the rapidly expanding area of terraced land.

PLANTING OVER TERRACES

With regard to planting operations, observations tend to show that except on very wide terraces wide drills, unless they can be made much more flexible in operation, are not adapted for use on terraced land particularly where the terraces are crossed at any angle and on the steeper slopes. The chief difficulty consists of planting the seed at different depths which often results in the seed's failing to come through especially on the top of the terrace, or being planted too shallow. Considerable difficulty with the press wheel type of drill has been experienced where the covering disks are located between the truck and the press wheels which gives a three-point contact with the ground surface. When the surface is low between the truck and press wheels, the disks do not penetrate the ground resulting in shallow seeding, and deep seeding occurs when the surface of the ground is high as at the top of a terrace. Placing the press wheels nearer the disks and the use of side wheels to carry the weight would largely remove this difficulty. The foregoing applies also but to a less degree when the drilling operations follow the terrace (Fig. 7). Where the practice of crossing terraces is followed, much better results are accomplished when the drilling is done at about right angles to the terrace. In Fig. 8 is shown a battery of three drills sowing wheat on a terraced field with a comparatively flat slope of from one to two per cent. The drills are crossing the terrace in the view at nearly right angles. Note the difference in the depth of the disks in the channel and on top of the terrace.

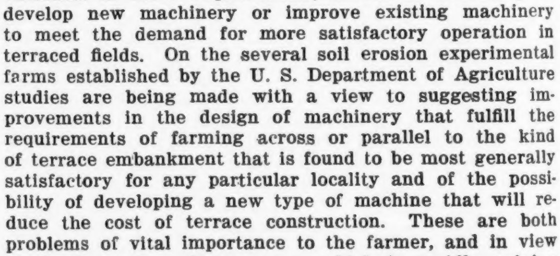
Lack of flexibility is also a criticism of cotton and corn planters in farming across terraces. It has been found practically impossible to keep both furrow openers at the same depth in crossing a terrace which results in planting much of the seed near the top of the terrace too deep. Shallow planting and failure to cover seed also results due to the unevenness of ground in crossing a terrace.

In the use of harvesting machinery not so much difficulty is encountered where the size of the machine is selected in accordance with the size of the terrace and the slope of the ground. This is particularly true of mowers. Greater difficulty is encountered in harvesting crops that require cutting close to the ground. There is a tendency for the heavier machines such as the grain and corn binder to creep down the side of a terrace embankment. This slipping causes more trouble in the case of the corn than the grain binder, owing to the fact that the former machine must follow the rows. This tendency to slip could no doubt be eliminated by the use of properly designed wheels for the machines.

Hay rakes do not possess sufficient flexibility for crossing terraces diagonally. It is therefore necessary to either cross the terraces at right angles or use a width of rake that will work satisfactorily when operated parallel to the terrace.

On the Hays experimental farm it was found that a 20-foot combine would work successfully over terraces 30 to 40 feet wide and on slopes varying from level to 4 per cent. This statement, however, applies only to combines that have a platform working independently of the separator and not fastened rigidly thereto. In the case of a combine with pick-up attachment used for picking up barley, the machine did not operate very successfully in crossing terraces, for the reason that the pick-up attachment was rigidly attached to the combine platform. A greater flexibility of operation with this equipment could be obtained by building the attachment independent of the combine platform similar to the manner in which the combine platform and separator are built as independent units.

Lack of suitable flexibility and of making easy and quick adjustments are the principal objections to existing machinery in farming terraced fields. Since it is impossible to build terrace embankments to conform to the requirements of farm machinery, owing to the great variation in these requirements, it will be necessary to develop new machinery or improve existing machinery to meet the demand for more satisfactory operation in terraced fields. On the several soil erosion experimental farms established by the U. S. Department of Agriculture studies are being made with a view to suggesting improvements in the design of machinery that fulfill the requirements of farming across or parallel to the kind of terrace embankment that is found to be most generally satisfactory for any particular locality and of the possibility of developing a new type of machine that will reduce the cost of terrace construction. These are both problems of vital importance to the farmer, and in view of the large terracing program which is rapidly gaining impetus throughout the country it is believed that the machinery manufacturer could well afford to lend his valued assistance and much needed cooperation in arriving at their satisfactory solution.



A terracing plow built in Texas

Types of Terracing Machinery Used in Texas[1]

By H. P. Smith[2]

MACHINES used in Texas to build terraces vary in size and cost from the small walking plow costing not more than $25 to the 60-horsepower tracklaying type tractor hauling a large road machine having a 12-foot blade, the whole outfit costing in the neighborhood of $7,000.

Attempts have been made to build terraces with a 10, 12, or 14-inch walking plow, but as a general rule the terrace is only partially built. In most cases some type of plow is essential in the building of terraces with the light ditchers and graders, because they are not always heavy enough to cut and move the soil without it first having been loosened by a plow.

There is a concern in Texas making a small walking plow which they call a terracing plow. They simply substitute a grader blade about 3 feet long for the regular moldboard. They claim it can be used to build terraces in light and sandy soils. When about three rounds have been made it works no differently than a regular plow, lapping one furrow upon that of another all being of uniform size. Therefore, it is necessary to again start back on top of the terrace and throw additional furrows upon the slight back furrow thrown up by the first plowing.

Sulky plows and brush breaker plows fitted with similar moldboards have also been tried, but the volume of soil moved is so small for these outfits that only the small farmer who wishes to terrace only a few acres can afford to consider using them.

The one-way disk plow has been advocated as a terrace building machine. You can build terraces with it, but I raise these questions in connection with its use: How much soil is moved? How far is it moved? How long and how many trips will be necessary to complete a terrace? It is claimed, however, that in the fall when the soil is very dry, it is practically impossible in the black-land sections to get regular terracing machinery into the ground, and a great advantage is experienced with the one-way disk plow under those conditions.

A type of disk harrow has been tried out in the building of terraces. It, like the one-way disk plow, has never gotten very far. At best the disk harrow may accomplish almost twice as much as the one-way disk plow, because it has a gang of disks working on each side of the terraces, throwing the soil toward the top and center.

Many bulletins and articles have been published telling how to make homemade V ditchers that could be used to build terraces. Yet I dare say, as a general rule, the average farmer prefers to put a few more dollars into a steel V ditcher if he has many acres to terrace. At best homemade V ditchers are not very efficient, since it is usually difficult to hold them in place. Also they do not scour well, and the quantity of soil moved is small.

Steel V ditchers have met with considerable favor as a terracing tool. Two ditchers of this type have been put on the market, the Martin and the Cook. The improved 30 series Martin has a rear tail coulter mounted on a swivel with a roller bearing. This coulter can be set so that, when a heavy load is placed on the blade, it will dig into the furrow sole and furrow wall and not slip out of the furrow as was the case with the earlier models. A swiveled wide-base wheel is mounted near the front and just back of the dirt blade to raise and lower the front of the machine about 3 inches. This facilitates turning at the ends of the terrace, and the load on the blade can be controlled to a certain extent with it. The seat is also mounted on a swivel which allows the operator to sit in a seat that is level, thereby making it more restful. The usual extension board is provided for the blade.

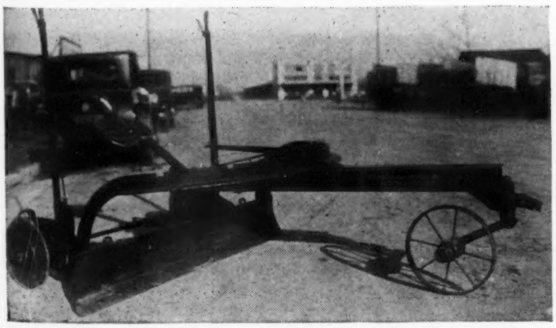
It is the desire of those who build terraces to build the best terrace with the least labor, in the shortest length of time and at the lowest cost. To meet these requirements, graders were brought out. There are now three ditcher-terracer-graders available, known as the Corsicana, the Texas and the Ideal. All are built in comparable sizes and sell at prices that do not greatly differ, but are within the reach of the average farmer.

Some of the leading terracing experts advocate a machine that will build a terrace in one or two rounds. In some counties of Texas the road commissioners have, during periods when constructing and grading of roads was difficult, hired the county equipment to farmers. In one county during the past summer there was such a demand for road-grading outfits that they were operated both day and night. Ordinarily it requires only about two to four rounds to complete a standard terrace with a road machine equipped with a 12-foot blade.

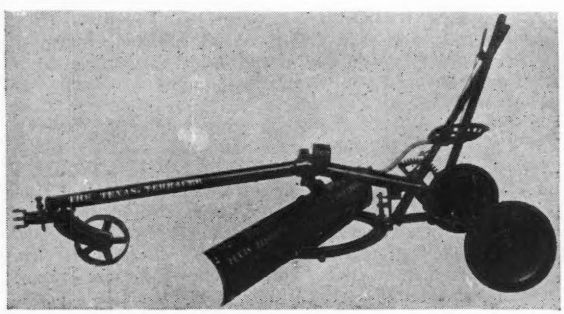
Since the average farmer cannot purchase such equipment, let us notice more in detail the construction and

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1930.

[2]Chief, division of agricultural engineering, Texas Agricultural Experiment Station. Mem. A.S.A.E.

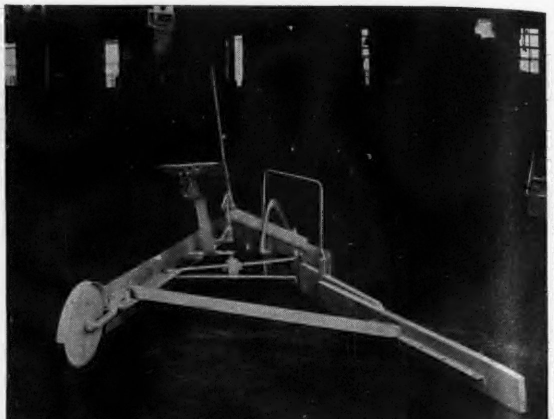


The Corsicana terracer-ditcher-grader which is manufactured in Texas



The Texas terracer

The Martin terracer-grader



Rear view of the Martin steel "V" type ditcher designed for building terraces

operating features of the terracer-graders. The frame of the Corsicana grader is constructed of heavy angle iron. Long levers are provided giving a mechanical advantage which makes raising and lowering of the blade easy. The quadrant for the lever pawl has ratchet like sections sloping in such a way that when the lever is pulled down it is not necessary to first draw up the pawl by means of the hand clasp; the pawl slips over the quadrant teeth with the action of a ratchet and pawl, thus making it possible to quickly raise the grader. The blade is rigidly attached and thus prevents changing the vertical angle. However, the horizontal angle can be easily changed to three positions giving an angle with the line of travel of 90, 125, 140 and 147½ degrees, respectively. The blade can be reversed to throw the soil either to the right or left. This can be done without stopping. To change the blade from right to left the left end of the blade is lowered until it is in firm contact with the ground. The right end is raised and, by releasing the latch on the beam, the blade is automatically swung around to a left-hand position. Two coulter-like wheels are attached to the lever quadrants, just to the rear of the blade to raise and lower the machine and aid in preventing the machine slipping sidewise when in operation. The hitch at the end of the beam is only adjustable vertically. The front end of the beam is supported by a swiveled wheel which serves as a tongue truck when the machine is drawn by a team.

The frame of the Texas terracer consists of different sizes of piping welded together. The beam is made of heavy 4-inch pipe. The front of the beam is supported by a swiveled wheel, while the rear is mounted on two pressed steel concave wheels set to run with the concave sides outward. They are connected to the beam by means of axles, to which the raising levers are welded. Just opposite to the hubs of each wheel a bracket is welded to the axle to allow the operator to place his feet on them and ride and also aid in raising the machine.

The blade is suspended under the beam on what is called a blade post, about midway between the front and rear wheels. A series of holes in the top of a casting welded to the rear of the blade allows changing the vertical angle with a horizontal plane from 92½ to 102½, 112½, 124½ and 132½ degrees, respectively. An angle iron bent to a semi-circle is bolted in a horizontal position to the rear of the blade which allows the blade to be set horizontally at angles varying from 90 to 140 degrees. The angle can be changed by the same method as that of the Corsicana machine. The hitch is adjusted both vertically and horizontally which facilitates taking care of side draft to some extent.

The frame of the Ideal terracer is constructed of heavy flat steel. It is well braced and arranged somewhat like an isosceles triangle, having the vertex at the front. A swivel wheel supports the front of the machine, while two coulter-like wheels located well back of the blade support the rear. The blade is suspended about midway across the two equal legs of the frame and is reversible, and it is claimed can be set at any angle desired, to the right or left or straight across. The parts on the back of the blade are made so the vertical angle can be changed. The hitch is not adjustable. An extension hand about 4 inches wide with a radius of about 4 inches less than that of the wheels is placed on the insides of each wheel to prevent their sinking too deep in loose soil.

During the spring of 1929, M. F. Thurmond and M. H. Byrom, two graduate students in agricultural engineering at Texas A. & M. College, were assigned the task of testing the efficiency of terracing machines. The main object of the project was to determine the draft, as affected by the volume of soil moved and the distance it was moved. Three machines were tested. It must be kept in mind that the tests were conducted only under one or two soil types and there are many factors that would possibly change the results obtained, hence the results given here only serve to indicate what might be expected.

Besides the graders the equipment used was a Davidson recording dynamometer, a cubic foot box and the necessary spades to handle the soil.

Data were collected on the draft, the number of cubic feet of soil actually delivered around the end of the blade upon the terrace in a 10-foot forward movement, and the horizontal distance the machine moved this quantity of soil. Tests were made both in wet clay and sandy soils while traveling on level ground, up grade and down grade.

From a study of the results of these tests it appears that the efficiency of a machine is directly proportionate to the ability of the blade to penetrate the soil and to its scouring qualities.

Other interesting observations made during the tests were as follows: Where the blade failed to scour, this could be aided by increasing the horizontal angle and, where possible, by tilting the blade forward. Under some conditions soil would pile up in front of the blade even though scouring conditions were good. Measurements in front of the blade of one machine showed that there was an average of 5.75 cubic feet continually in front while an average of 5.37 cubic feet of soil was being delivered in 10 linear feet. On those light machines which do not have sufficient weight and wheel traction to hold them it was found by adjusting the hitch approximately 25 per cent more soil could be moved.

Problems Involved in Developing Terracing Machinery[1]

By A. T. Holman[2]

THE experience we have had in North Carolina, in solving the problem of controlling soil washing, leads us to believe that the main factors to be considered in the design and construction of terracing equipment are as follows:

1. There is a real need for a small grader that can be drawn satisfactorily by two horses. This is for use on 20 to 60-acre cotton and tobacco farms.

2. All ditchers and graders should be so improved that it would be possible to make reasonably short curves in the terrace line without having the machine slip from the true line it should follow.

3. There is a need for improved design on all present terracing equipment so that it will take to the ground and go in deep enough where the soil is hard and not too deep where the soil is soft. It appears as though this will require either broad, flat slides or low wide wheels.

4. The design of present equipment should be improved so as to prevent side slippage when the machine is working on steep hillsides or working on the edge of a newly constructed terrace.

5. The grader must be so designed that it can be reversed quickly and easily.

6. The design of the hitch and the application of power is as important as the design of the terrace grader itself. There should be a definite study made to determine the number of horses or size tractor required for the best operation of certain machines. When a terracer is marketed, it should carry with it definite recommendations for the best possible hitches using either horse or tractor power. It would be desirable to have hitches developed that would permit the tractor or team to work on solid ground rather than on the soft soil of the terrace.

The following terracing recommendations are based on soil and farm conditions in North Carolina with due consideration to the particular type of terraces recommended:

1. For Coastal Plain conditions and other parts of the state where the slope of the land varies from 2 to 6 feet in 100 feet, a terrace 20 to 22 feet wide and 20 inches high is recommended.

2. Where the slope varies from 5 to 10 feet in 100 typical of most Piedmont soils, we recommend a terrace 16 to 18 feet wide and 18 inches high.

3. For the steeper lands with slopes of 10 to 18 feet in 100 feet, frequently found in Piedmont and Mountain conditions, terraces 12 to 15 feet wide and 15 inches high are recommended. These widths include not only the terraces, but also the water channels and a width equal to the water channel below the terrace.

4. Terraces should be so constructed that the field, other than the terrace, maintains its natural slope and that the developing of terraces does not change the field topography into a series of marcel waves.

5. In crossing gullies terrace lines follow the contour of the land so that high dams are not necessary.

6. Plowing the first few years should be toward the terrace. After terraces are high and wide enough, plowing should either be across or away from the terrace.

In this great national program of conserving soil fertility the engineers and manufacturers of terracing equipment have the opportunity of not only serving themselves well, but also making it possible to give terrace construction an impetus not otherwise obtainable.

[1]Abstract of a paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, December, 1930.

[2]Extension agricultural engineer, North Carolina State College.

Engineers and Economics[1]

ALL this . . . (economic inefficiency) . . . . is an old story to economists — even to their own lack of understanding. . . . . . .

. . . .

What is relatively new is that engineers are beginning to concern themselves seriously with the workings of the economic machine. That is a most auspicious development — one which economists will welcome. . . . . . . I hope that engineers will join with economists in working on the program of economic organization, and not merely call upon the economists to produce the science and the art which is needed. . . . . .

. . . .

. . . . . economists have sought to practice social engineering from long before the days of Adam Smith to the present year of grace. Most certainly they will continue that practice in the future, and here, too, they would like the help of engineers. But they know from long experience that the difficulties of social engineering are many.

. . . .

. . . . . Let me repeat Mr. Flanders strong statement once more:

"The Engineer knows — all engineers know — that, if some omniscient dictator were installed as ruler of the United States they could provide for him raw material, machinery, and trained labor sufficient to flood, bury, and smother the population in such an avalanche of food, clothing, shelter, luxuries, and material refinements as no Utopian dreamer in his busiest slumbers has ever conceived."

Now, if Mr. Flanders is right, if you all know that it is feasible from the engineering viewpoint to abolish poverty, then you should present this stirring possibility to your fellow-countrymen with all the force and persuasiveness in you. By so doing, you could concentrate attention upon the need of improving our economic machinery more effectively than any other set of men. . . . . .

. . . .

. . . . . . As human affairs go, we have prospered in this country. Getting us to change our habits for something better will involve re-education as well as invention. And re-education is a slow process.

Slow; but not hopeless. The very drift of affairs is coercing us to change. Why not mix all the intelligence we can muster into this process of making over our own habits, as we put intelligence into the continual rebuilding of our industrial plants? In fact we are doing just that with increasing skill, generation by generation. If engineers will join with the other professions who are working on the problem, we shall get on faster. For the present workers need a clearer vision of what is possible in production, and a more constructive attitude of mind. Those needs engineers can supply.

[1]From "Engineering, Economics, and the Problem of Social Well-Being—The Economists View," by Dr. Wesley C. Mitchell. "Mechanical Engineering" Vol. 53, No. 2 (February 1931).

The Farm Manager and His Responsibility to the Profession[1]

By Frank W. Reinoehl[2]

THE agriculture of the United States and Canada is still young; so young, that in the western portion of the states and the western provinces of Canada, most of this territory has just within the last decade approached the stage of the inevitable transition. It has been comparatively easy in the past for the pioneer farmer in either country upon receiving a virgin soil free from weeds and free from any exhaustion of fertility, to raise crops at a profit, or at any rate make a comfortable living with practically no first cost of the land and no taxes. In a true pioneering spirit, willing to deny themselves and live and farm as pioneers, with living costs low and practically all coming from the farm, satisfied with this lot, these farmers lived, acquired additional lands and were satisfied with their economic condition, because farming in those days was first a mode of living, and secondly a business.

The farmer in those days was in a relatively favorable position; he was always sure of something to eat and wear, a house in which to live, fuel for it, and with these things, the much boasted farm independence.

As machinery was introduced the size of the farms became greater; with this and the constant increase in population, there was always a demand for farm lands. Out of the earnings of homesteads and lands acquired for practically nothing, many farmers and companies were able to increase their holdings. In those days, anyone in the market for improved farms was expected to pay a considerable portion of the purchase price in cash, so that the farm would be paid for, not out of its earning power, but out of the combined capital put into it and the productive power of the farm as a whole. If the farmer's equity in the farm at the beginning was sufficient, he succeeded; if not, the demand for farm lands made it possible for him or his creditors to dispose of the farm at an increased price. The result of this was that the value of farm land has always been on a price basis higher than its real productive value. Land values were built on speculative prices constantly increased by active demand and unearned increment, and this was the basis of values on which farm mortgage loans were made.

In the case of the mortgagors, the equipment already paid for and the equity in the land above the amount of the loan, were always a part of the consideration in meeting interest and principal payments.

Farmers securing their first holdings for little or nothing, paid for additional lands at advanced prices out of their earnings, and with no accounting system, considered the land was paying for itself at the advanced price. Many a time have we heard the tale from farmers of how easily the additional quarter paid for itself. They forgot all about the equipment already paid for, the labor and many other items of farm production, all chargeable to capital invested and previously acquired or paid for. It is certain that investment bodies did not take such facts into consideration when making loans and appraisals. Suddenly it was discovered that interest and principal payments on farm loans could not be met. For a number of years, if a collector got too tough with a farmer, the farmer went somewhere else to get a loan to pay off the original loan and accumulated interest. Thus loans pyramided and prices of lands followed.

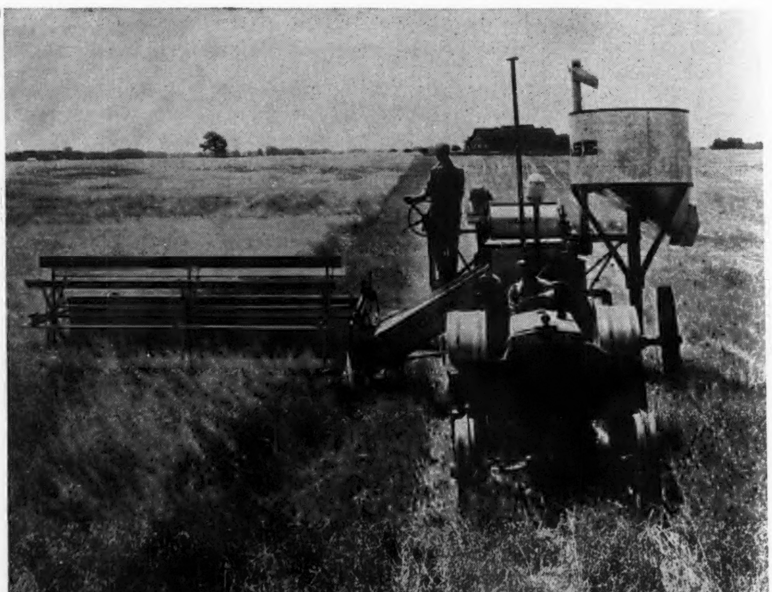
Times have changed; the new virgin soils are no longer pouring forth their streams of wealth at a minimum of labor and expense. Farming is no longer self-sufficient. Farmers to be prosperous now must know how to handle soil depleted in fertility; soil filled with persistent weeds and death-dealing plant diseases.

Farming in order to be prosperous, must be on the

[1]Paper presented before a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers in Chicago, December, 1930.

[2]Chief farm manager, Colonization Finance Corporation of Canada, Ltd.

The time element is far more important on the farm than in mass production in a factory. Speeding up farm work all along the line on the family farm is absolutely necessary, if desirable standards of living, and farm life, are to be maintained on the family farms of America



A corn sheller with a seed corn tipper so that tips and butts may be shelled separately

same price level as other industries from which it now purchases in ever-increasing quantities. Farmers are now dependent upon the purchase of many articles of commerce and must have economic equality. Certain necessities once considered luxuries must be a part of farm life. Graded and consolidated schools, paved roads, and many other similar things lead to a tax almost equal to a good sized rental. The taxes in many cases are far more than a fair rate of interest would be on the original investment in many farm lands. Moreover, this tax is levied on a valuation much higher than the productive value of the land. Many other changes have come about. A $75 buggy is replaced by a $750 auto. This is a good illustration of the increasing expenses of farm life. The higher prices for farm products during the past ten years barely balance the decreased yields through the toll of weeds, disease and run-down soil. There is nothing left to take care of the increased costs of production and the increased costs of farm living.

As an outcome of this changed situation, resulting in a farm depression, a large number of farms have come and are still coming into the hands of mortgage companies.

A new basis of land values is now required. Unearned increment, sale price of lands built on demand, absorption of adjacent lands by expanding farms, ready loans on agricultural lands as security, are out of the picture. Land has but one value now, and that is its productive value. A farm purchaser can pay for a farm just what that farm will pay for itself when properly handled. One of the serious questions before all investment bodies is what is land worth? It is also a serious question before all agencies handling land. Mortgage men want to know the real value of farm real estate on hand and the present value of millions of loans on agricultural lands.

Farm managers and agricultural service agencies must know, in liquidating and handling farms, at what such can be sold with a reasonable expectation that the purchaser can succeed. Here is a real problem for agricultural economists, agricultural engineers and efficiency experts.

One of the tendencies of the times since the war has been to place large tracts of land or groups of farms under better management, so-called "farm management." This development has taken place in several directions. In some cases a hired manager deals with a large tract of land operated centrally or by hired labor, or with large tracts of land divided into a number of family-sized farm units for operating purposes. In other cases farm units have been assembled in zones for management purposes.

Agricultural service agencies which offer their services to a large constituency extending over a large area, are necessary. What has given an impetus to the demand for such services is that the changed conditions in agriculture demand that farming actually pay its way. Farming is now more difficult and requires a much greater degree of technical knowledge and skill. Better business management and handling of financial problems, both in marketing and in purchasing, are essential.

For many decades the departments of agriculture, agricultural colleges, experimental stations and demonstration farms have made available much valuable information for those engaged in farming. One of the constant problems of such agencies has been the matter of getting this information over to the farmer on the land and in getting it into practical use on the farm. One demand for the services of farm managers is to bring such knowledge into actual farm practice.

The farm manager must be a well-trained agriculturist. He must be far more than that; he must be a practical farmer who knows how to adapt technical knowledge to farm conditions; and all this is of very little use unless he knows human nature so that in dealing with family farm groups, he is able to secure from the farmer his cooperation in improving the farming program.

Because of the lack of adequate financial returns, there is need for the reorganization of the farming industry. This problem differs from that of the ordinary industry where the mere scrapping of the old machinery and the installation of new and up-to-date machinery and methods, are the necessary steps for successful operation. In farming it is impossible to scrap the old farm or the old improvements and even to a large extent the machinery and livestock on the farm. What is found there, must to a large extent be taken over and improvements made on it. Necessarily, this is a slow process and the patience of Job is required as one watches and looks forward to the time when plans now put into effect materialize into full fruition.

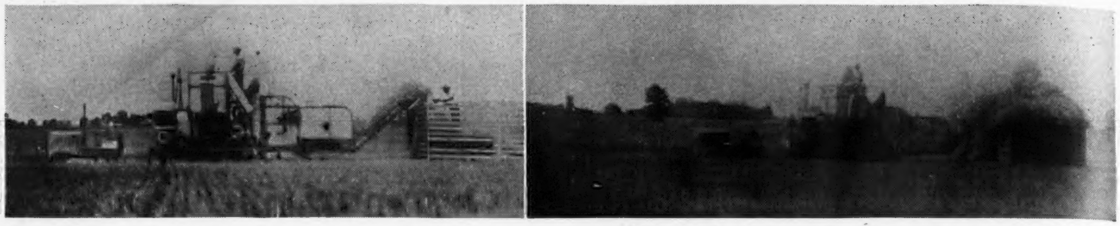
There are certain services that every farm manager must be ready to give and every agricultural service agency must be ready to offer. A list of these shows to some extent the necessity for men well trained, not only in technical agriculture but also in essential business practices:

1. Selection of tenants, purchasers and laborers
2. Negotiations of lease and sales contracts
3. Soil surveys
4. Cropping plans and rotations; seed selection and treatment of seeds
5. Supervision of livestock and general farm operations.
6. Purchasing equipment and supplies
7. Marketing of farm products
8. Audits and financial statement of farm operations to owners and companies
9. Appraisals and liquidations.

Just at the present time it is very essential that a new basis for land appraisals be reached. From now on there is but one basis for land valuation and that is its productive value.

There are very few farmers who now are in a position to pay down the usual one-third or one-half that was required in the old days. The result is that if much of the land now in the hands of the mortgage companies is to go permanently into the hands of farm owners, it must go at a price based upon its ability to pay at that price. As stated before, one of the questions before all farm managers and farm management services is to reach this basis, and this must be reached through accurate data which does not now appear to be available.

The situation in which agriculture has been placed during the past ten years, and the development of the need for better farm management, has led to certain dangers. There are men entering this field who are overselling the idea, setting forth accomplishments far beyond what can be attained, that there is some danger of this work being discredited. It is very easy to claim too much for efficient farm management and sooner or later



Straw on the fields harvested by The Farms Operating Corporation the past season was worth $2,000. These two pictures show a device, attached to the rear of the combine, developed by Mr. Van Scholk, head of the agricultural engineering department at Michigan State College, and the manufacturer of the harvesting equipment to save this straw. This is a good illustration of just one of the many new agricultural engineering problems pressing for solution

there will be a reaction that will be exceedingly harmful to the whole profession. Some of the glowing pictures that are painted remind us of the quack doctor's cure-all promises.

I have observed with approval that the American Society of Farm Managers has organized for the purpose of standardizing certain practices in farm management. It is to be hoped further that this organization will also set up certain standards of qualifications for men in this profession and thus give it a real professional status.

In meeting with the American Society of Agricultural Engineers, I would like to say that there are many problems which are mutual between the agricultural engineer and the farm manager. I have felt for many years that in the matter of farm buildings there was need for certain standards and I am very glad to note that this is one of the problems which is under consideration by this organization. There is a certain phase of this question which is to my mind most important. That is the value of the buildings in relation to the total investment. Many farms which come into the hands of investment bodies these days, have splendid buildings, and in many cases the overhead of these buildings has been the cause of the financial failure. As practical farm managers, we are at once face to face with the question as to what such improvements are worth to the farming program regardless of their cost or regardless of their replacement value. Surely on certain sized farms, and in certain types of farming, pretty definite limits as to relative investments in lands and buildings, could be set up by such an organization as the American Society of Agricultural Engineers.

Just as there is great need in standardization of construction and costs of buildings, so is there need for standard equipment for certain farms where certain types of soil are dealt with and certain types of farming are carried on. It is a common experience when a new farm is taken over, to find the equipment of the farm very much out of balance. While there are certain changeable factors such as weather conditions, yet there are sufficient constant factors that it might be possible for the American Society of Agricultural Engineers to set up standard equipment for a farm of a certain type of soil and type of farming operations. Whether this appears possible or not, every farm manager knows that he is required to do this very thing on every farm he operates. Many farmers have not learned that a farm of certain size and of certain kind of farm operations, can carry just so much investment in equipment. It might be said further that many dealers in machinery have not recognized that it is possible for a farmer to overequip himself to such an extent that there is no chance for him to succeed. Another matter along the same line and a part of the first is the unbalanced power units which we find on many farms. Definite standards and tractor sizes could surely be recommended for various sizes of farms with certain types of farming operations. Definite recommendations and standards set up along these lines, based upon accurate data and studies, would prevent many mistakes during this period of the reorganization of farming methods.

As a farm manager I would like to see far more fact material available regarding various types of farm machinery, coming from some unprejudiced source. We are always glad to see and hear the story of our friends and coworkers, the men who supply us with the machinery. We have learned that we get but one side of the story here. Unbiased information along technical lines, without specific recommendations, would be most valuable to us, and such information would supplement the practical observations and experiences of those operating the machinery.

Another important problem on many farms is that of securing an adequate farm water supply. It is surprising how little information there is to be had on this subject in this country; far more can be obtained from other lands where more work has been done along this line. In this country the emphasis has been placed on problems of farm water supply on the supposition that the primary question of an available supply of water has been solved. I believe the agricultural and geological engineer could render a real service to American agriculture by undertaking a real study of this basic problem, which is a most serious problem in certain sections of the country. Farm managers are always faced with the seriousness of this matter.

So-called chain farming or corporation farming is not the present solution of the problems of agriculture. The major portion of farm production for many years to come will be on the family-sized farm, with a strong tendency toward a larger acreage per family. The great problem then is to secure a higher efficiency on the family farm. The rotation system, the improvement of soils, better seeds, feeds and feeding, better livestock and better machinery are all but a part of the problem. Over and above, and underlying all these, is the more important matter of the doing of the actual work of the farm. The human equation is the real problem. The earlier conditions of agriculture, as set forth at the beginning of this paper, did not necessitate efficiency in actual farm operations such as seeding, cultivating, plowing, harvesting, combining, threshing and the like. Now all these operations must be carried on just as efficiently as labor performs in the factory. The time element is far more important on the farm than in mass production in a factory. Yet there are no standards of accomplishment in the various operations. I have found it necessary, in dealing with the average farmer, to set before him certain standards of accomplishment each day; so many acres must be plowed, so many acres must be cut with the binder, so many acres or bushels should be threshed. Without such standards and without such ideals being set before the average farmer, the rate at which such work will be accomplished is entirely too low to secure adequate financial returns from farm operations. I would like to see established for our various units of machinery, dealing with types of soil and types of farms, certain standards that could be referred to and held up to the farmer as ideals to be achieved in his daily operations. Speeding up farm work all along the line on the family farm is absolutely necessary, if desirable standards of living, and farm life, are to be maintained on the family farms of America.

Developing Machinery for Beet Production[1]

By E. M. Mervine[2]

NOW that one man and machine can block beets sixteen times as fast as is done by hand labor and top beets ten times as fast as the fastest hand labor and twenty times as fast as good hand labor, we are challenged to incorporate these methods into a mechanically practical and economically sound process.

The annual value of the beet crop, as sugar, in the United States is $120,000,000.00. The culture of sugar beets and the manufacture of sugar from them are so closely allied as to constitute, virtually, a single industry. Beet sugar production is primarily an agricultural industry, more than 80 per cent of its personnel and about 50 per cent of its total capital being employed in agricultural processes. Costs of producing sugar beets are about 50 per cent of the present total cost of producing refined beet sugar. In other words, beet farmers receive approximately $60,000,000.00 for their beets annually.

On the acre basis the grower averages nearly eleven tons of beets for which he is receiving this year (1930) $7.00 per ton. This tonnage varies with localities, farming methods and other factors, sometimes being so small that the crop is not considered to be worth harvesting and sometimes being 30 or 40 tons per acre. The average for Colorado this year is close to 15 tons per acre, for which the grower is receiving $105.00.

Practically the entire beet acreage is contracted for before the planting season, so that both the manufacturer and the farmer have a very definite idea as to what the yield for the season will be. The manufacturer, frequently throughout the season, makes estimates as to the yield of the crop and the farmer can rather definitely foretell what his cash return will be.

Due to this close organization between the manufacturer and the grower there is a condition that is quite different than is found in other agricultural processes. The farmer, before the opening of the season, can very definitely know where he will market his crop and how much he will receive for it, without any concern as to what the market price will be at that time. Of equal importance is the advantage that, when a new method of growing beets is determined, whether it be applying fertilizer or a new machine method, the close organization between the manufacturer and the grower is again manifested. The manufacturer, through the district superintendents and their local field men, who are in constant contact with the farmer, can quickly and effectively aid the adoption of the new method.

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, Chicago, December, 1930.

[2]Agricultural engineer, division of agricultural engineering, U. S. Department of Agriculture. Mem. ASAE.

The average cost of producing an acre of beets, when including all overhead costs and the growers own labor, exceeds the returns on the average yield of beets. With a yield of eleven tons at $7.00 per ton the farmer would lose about $11.00 per acre if his costs were the average of the United States. The Colorado Agricultural Experiment Station from 1922 to 1927 made cost studies which showed low cost farms averaging one year $60.20 per acre but an average of all their studied farms for the period of $88.23 per acre. The average returns on these farms was $113.73 per acre.

The cost of producing an acre of beets is as high as it is largely because of the labor requirements; it consists of the following: Labor, 46 per cent (contract labor, 26 per cent; machine operation, 20 per cent); horse labor, 15 per cent; capital charges, 34 per cent; equipment, etc., 5 per cent.

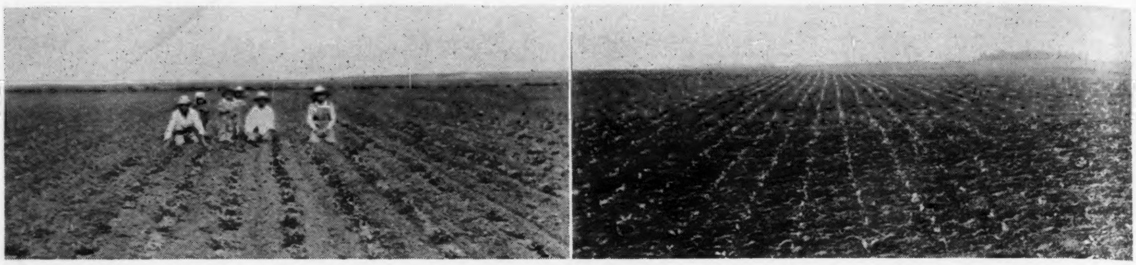
It requires approximately 90 hours of labor for producing an acre of beets. This is entirely out of line with the requirements for corn where 10 per cent as much labor is ample.

The amount of labor required to perform once the various machine operations employed in the production of sugar beets is shown in the following table. Not all of these operations are performed on all farms but it is evident that the labor requirements for these jobs can be materially reduced by changing the size of units or by combining operations, or adopting different power units:

Operation	Man-Hours per Acre
Manuring	13.4
Cleaning ditches	1.4
Removing trash	0.8
Disking before plowing	1.1
Crowning alfalfa	4.7
Plowing	4.6
Disking after plowing	1.3
Leveling and floating	0.9
Spike tooth harrowing	0.7
Spring tooth harrowing	1.1
Rolling, soil packing, corrugating	0.8
Hauling fertilizer	0.3
Hauling seed	0.1
Planting seed	1.0
Preparing for replanting	1.9
Replanting	1.1
Harrowing	0.6
Rolling	0.8
Spraying	0.9
Cultivating	1.7
Plowing ditches	0.8
Irrigating	2.6
Lifting	4.4
Loading and hauling	11.0

The number of man-hours of machine operation or indirect labor ranges, in Colorado, from a yearly average of 38.05 per acre on low cost farms to an average of

(Left) This view shows a field of drilled beets before the operation of cross cultivation was begun. (Right) Cross cultivating the field at the left



(Left) This shows the blocks of young beet plants left after the first cross-cultivation, and the blocks being thinned by hand. Three adult workers thinned on the average 1¼ acres each per day as against ½ acre per day the old way, and earned $10.00 each per day. (Right) This shows the same field after hand thinning

67.64 man-hours per acre on high cost farms, and an average of 40.69 man-hours per acre for all farms studied by the Colorado Agricultural Experiment Station during the six years 1922-27, inclusive.

The most logical way to reduce production costs is to mechanize the present hand operations listed as contract labor. In addition to the contract price of from $23.00 to $26.00 per acre paid these laborers for the blocking, thinning, hoeing, and topping, there are numerous other costs which are difficult to itemize. The labor is provided with living quarters, garden facilities, etc., which has been estimated as valued at $1.51 per acre. In some localities the source of contract labor is at such a distance that the transportation cost is a big item.

The greatest demand for contract labor comes in May and June for blocking and again in October for topping. In order to satisfactorily mechanize this work it is equally necessary to provide machines for both the blocking and harvesting.

The beet seed ball which may have from one to nine germs in it, is so protected by a hard shell that it requires a good seedbed with moist soil compacted around it to insure germination. When it does germinate, there is a possibility of several plants; there is also the possibility of spaces in the row without plants. Present practice is to plant from fifteen to twenty pounds of seed per acre which may give eighteen seedlings per foot of row, and the desire is to have just one plant to a foot of row. This result is now obtained by hand blocking and hand thinning.

Proposals for mechanical substitutions for these operations include (1) cross blocking, (2) row blocking, (3) check row or hill planting, and (4) transplanting.

Cross blocking is merely an adaptation of the regular beet cultivator drawn across the field at right angles to the direction in which the field was planted. Some work has been done on this method in past years, but this year very extensive experiments have been conducted and thousands of acres have been cross blocked.

This one year's observations would indicate that the machine is more accurate than a man's eye and hand in leaving a "stand" of beets. Practically every field observed showed an equal or better stand after mechanical blocking than where hand blocked.

The cultivation by cross blocking is noticeably an advantage over hand blocking, both in that weeds are more thoroughly eliminated and also that the ground is left in better shape for later operations.

Not only are the results of cross blocking apparently desirable, but the equipment necessary is so readily available that this method gives evidence of speedy adoption.

Many attempts have been made to develop a machine to block out beets by traveling lengthwise of the row. It is possible that this system may gain favor because of greater ease of traveling in the same direction as the rows are planted, especially in the irrigated areas.

Check row or hill planters are proposed as a substitute for drilled beets with two objectives in view: (1) It would eliminate the necessity for blocking and perhaps permit cross cultivation; (2) it would make a material saving in the cost of seed, as seed costs 15 cents a pound, or approximately $3.00 per acre.

Transplanting is proposed as an alternative for blocking and thinning. This method of eliminating the necessity of blocking and thinning has the added advantages of being able to use selected hardy plants and of giving the plant an early start in the season, which should result in greater resistance to disease and greater tonnage.

Transplanting equipment is in the experimental stage and the entire method calls for considerable study.

Harvesting beets incorporates several processes, the practice now consisting of the operations:

1. Using the mechanical beet lifter in order to loosen the beet in the ground
2. Pulling two beets at a time by hand, knocking them together to rid them of dirt, and throwing them into a windrow
3. Driving through the field pulling an A sled which cleans and levels a 4-foot path
4. Topping the beet by hand, picking up individual beets holding them with one hand and cutting the tops with a long knife held in the other hand, allowing the top to fall into a windrow and throwing the topped beet into a pile in the cleaned path
5. Scooping the piled beets into a truck
6. Hauling on an average of 1¼ mile to the beet dump.

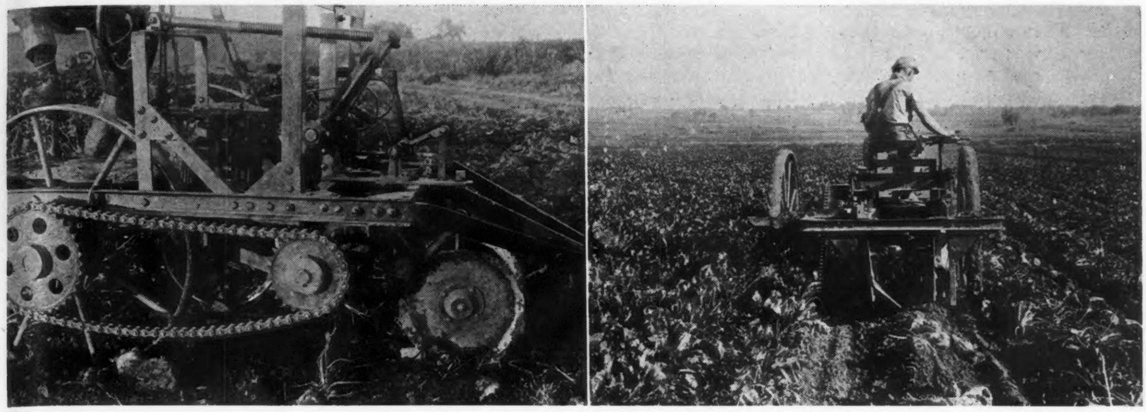
Local practices differ somewhat, but the total amount of effort in harvesting is about the same everywhere.

Mechanical harvesters of three types are proposed: (1) The beet would be topped in the ground, then lifted and elevated; (2) the beet (top and all) would be lifted and elevated, and then mechanically topped in the machine; (3) the entire beet would be elevated into the truck and hauled to a central topping plant.

The requirements for the successful harvesting of beets are (1) that the proper amount of crown be cut from the beet in the topping operation, (2) that the top be saved, (3) that the beet be separated from the dirt or clods, and (4) that the beet be elevated into the truck or wagon.

It has always been supposed that the most difficult obstacle to the development of a mechanical harvester would be that of mechanical topping, but preliminary tests indicate that it is not only possible but quite practical. Several experimental machines during this harvest season have demonstrated their ability to satisfactorily top beets even though adverse conditions were encountered. It frequently happens that one beet will grow high above the ground and the next one may have its crown entirely below the surface of the soil. The topper has to contend with the condition of beets with large foliage and then with beets with small tops. Some beets are held firmly in the ground while others are easily dislodged.

There have been numerous attempts made to build harvesters of the type which tops the beet in the ground. The elements of this machine are first a "finder" which is for the purpose of locating the crown of the beet for proper topping. The second feature is the knife for doing the topping. The third element is the lifter which is sim-



Views of a beet topping machine (left) and beet digger (right) on the experimental farm of the Great Western Sugar Company in Colorado. These machines are manufactured locally. The former tops the beets and rakes the tops away, leaving the ground clear for the digger which follows close behind

ilar to the present beet lifter. The fourth part is an elevator.

Finders that have shown the most promise have been of two types, one a track-type and the other a wheel, both for the same purpose. The finder travels down the row, and as it climbs over the beet it gages the height of the crown. This type of finder serves another purpose. It is power driven at a speed which tends to pull the beet back against the knife. This feature overcomes the tendency of the knife to push the beet forward in the ground and also prevents breaking off the far side of the beet. The knife used for topping the beet is attached to the finder in such a way that it will properly do its work. Knives have been either power driven or stationary. These have not been compared under similar conditions, so it is impossible to tell whether the more simple knife will or will not replace the power-driven one.

The greatest difficulty encountered is to satisfactorily separate the beet and dirt. Mechanical separators so far have not answered the purpose. It is for this reason that the second type of harvester has been proposed. It has been supposed that by utilizing the beet top the beet could be pulled from the ground, thus reducing the amount of dirt that is now lifted with the ordinary lifter. Preliminary trials would indicate that the beet can be satisfactorily topped in the machine after having been lifted in this manner.

The third system of harvesting is the central topping plant which consists of (1) lifting and loading the beets into a wagon or truck, (2) hauling to the farmer's feed lot, (3) dumping onto a conveyor table, where (4) a man feeds the beets into a mechanical topper, and (5) conveyors that carry the tops to a stack and the beets to a hopper where they can be quickly loaded into trucks for hauling to the dumps. The arguments for this system, which has never been tried, are that it would give two opportunities to separate the dirt from the beets, that the tops would be cared for in the most approved manner, that a man would be incorporated into the harvest method at the most opportune place, and that the hauling capacity of the trucks would be increased.

Tops are a valuable by-product of the beet harvest. The green tops are composed of about 25 per cent crown and 75 per cent green leaves. The top has an average moisture content of about 85 per cent when first cut. The green top may be 70 per cent as heavy as the beet tonnage harvested. The tops when siloed have a value 1.6 times as great as those left in the field to cure. A recommended practice of caring for the tops is to pile them while green in a stack, 6-inch layers of tops alternating with a 2-inch layer of straw, making a stack 8 to 12 feet wide and about the same height.

The more common way of utilizing the beet tops is to pasture them from the windrows in the field.

The need of cutting the cost of producing the beet crop and the possibilities of mechanizing this crop are so great that our combined effort for getting the desired results is essential.

Discussion

By Carrol T. Lund[3]

AN IMPORTANT question is how the beet sugar industry can expand and bring agricultural and industrial development, and at the same time bring about employment for thousands of white laborers. This can

[3]General agriculturist, American Beet Sugar Co.

(Left) This is the same beet field, as shown in the other pictures, 20 days after it had been thinned by hand. (Right) Cross cultivating 8 rows of sugar beets at one time at a total cost of 30 cents per acre

be done provided we can bring about the mechanization of operations now being done by field labor, which is mostly foreign labor. If we can reduce the amount of so-called foreign labor, and at the same time substitute white labor for what is necessary, as well as increase the net revenue to the grower, we will then secure political support, as well as the support of organized labor, which will benefit us directly and indirectly, and also the support of all social organizations.

The reason for mentioning this is that some of us feel we have made considerable progress in this direction, and especially so in the Middle West where we are now endeavoring to grow beets similar to methods being practiced in the production of corn, namely, to cultivate the rows both ways instead of in the customary row method. As yet we have no check row drill, as is used in corn planting, but we have worked out simple cultivator attachments, that make it a very easy process to go across the rows, leaving small clusters or blocks at given intervals. After going over a field in this way, it then has the same appearance as a corn field. This so-called "cross cultivation" eliminates hand blocking entirely, and at the same time eliminates most of the weeds. The spacings depend on the individual ideas of the growers, but most of them feel that 18 by 18 inches is about as close as it is practical to cultivate both ways, and at the same time obtain a satisfactory number of beets per acre. On a basis of 18 by 18 inches, the number of beets is usually more than one actually leaves when the work is performed by hand. Most growers, as well as the beet people, feel that they do have more beets per acre, but actual counts have not demonstrated this on the average.

To show how this practice is developing, during the 1929 growing season we had a few scattered plots to demonstrate mechanical cross cultivation (by this we mean continuous cultivation both ways), and in addition we had two growers who tried small acreages of 2½ acres each on a commercial basis. These parcels were observed by many growers, as well as by others interested in this work, so that during the past season of 1930 this sort of crop culture was practiced by five hundred growers on some 10,000 acres, which is quite an increase over the first year. We estimate that in 1931 this will be increased to from 40,000 to 50,000 acres.

The savings to the growers on these 10,000 acres has really meant something worthy of their consideration. The hoeing contract alone calls for $6.00 per acre. This year the average cost of hoeing on this acreage was approximately $3.00 per acre, or a reduction of 50 per cent in cost, and a saving of some $30,000.00. The thinning of these beets required about half the labor that is ordinarily used, because the cultivation both ways had eliminated the hand blocking, and had left the soil in such a loose condition that workers could cover more than twice the acreage per day than they could otherwise. This lessening of the actual work, and the increased earning power attracted white labor, and from local towns this year approximately 4,000 acres were handled by white labor which received the contract price of $8.00 per acre, and earned from $3.00 to $10.00 per day, depending on their willingness to work.

The U. S. Department of Labor's representatives who observed this work were highly enthused, and felt that this was really a step in placing it on a basis that should be attractive to organized labor. It is my understanding that a report is on file at Washington urging that particular department to support the beet industry, and assist in the mechanization of labor operations, which in turn would make an increase in the amount of work for white labor. The same expression has been voiced by social workers in the various beet communities. This program has the support of other departments of the federal government. We also have the support of the agricultural colleges in Iowa, Minnesota, and North Dakota. I mention this to show that it is not the opinion of only a few, but has attracted the support of other institutions.

Besides saving some $30,000.00 in hoeing, the sugar companies shipped in twenty-two hundred fewer laborers than in the past, and made an additional saving of some $50,000.00 in transportation. It has been estimated that this particular acreage produced on an average of at least two tons to the acre more than if this same acreage had been grown the old way. Accurate data on this is difficult to obtain, but we do know that hundreds of acres were saved by this practice, which otherwise would have been a total loss. Again growers did not cross cultivate the best stands, and in some instances only worked the weedy portions of the field. This meant increased revenue to the extent of approximately $140,000.00, or a total of $220,000.00 for the acreage so handled. If we can further this work on 50,000 acres during 1931, we will show a total crop saving approaching a million dollars. This method might not apply all over the country, but many feel that it can be modified to apply to local conditions.

With cross cultivation practically proven as a means of reducing labor costs per unit and increasing crop production, and at the same time eliminating foreign labor and substituting white labor where necessary, the industry is confronted with the necessity of developing a harvesting machine, which in itself will replace all harvest hand labor, and substitute white labor where necessary. Development work on beet harvesting machines by individuals

Cultivating eight rows of sugar beets at one time on Ranch No. 31 of the Spreckels Sugar Company. This tractor works day and night, cultivating during the daytime and hauling a 21-foot roller at night. In the rolling operation 80 acres are covered each night

and companies has been going on for years, but it is only during the past year that some real practical possibilities have been shown. Several likely machines have been in operation in the western United States during the past season. We had the opportunity to work with a machine this year in the Red River Valley, which topped beets in the ground, lifted the beet, and elevated it to a truck or hopper attachment. The topping, which is the difficult problem, seemed to be solved, and from the work done was more uniform and more desirable than hand labor work. Of course this machine was not mechanically perfect, nor as yet an economic unit for growers, but the possibilities for perecting such a machine were clearly indicated. From what work we carried on it was clearly demonstrated that a two-row machine could harvest beets in actual cost of around 30 cents a ton or $3.00 per acre as against the present cost of around $12.00 per acre. By use of cross cultivation and a mechanical harvester, the hand labor requirement would be reduced to a minimum, and a saving in hand labor costs of at least 50 per cent or more would follow. When we consider that this would mean around $12.00 to $15.00 per acre, or a total in excess of $12,000,000.00 on the acreage now under cultivation in the United States, one can visualize just what opportunities would present themselves in agricultural and industrial development, and what would be to allied industries a means of unemployment relief.

This industry should offer a real opportunity to do something worth while, not only as a means of real agricultural relief and the employment of thousands of white people, but as a means of bringing about increased farm production and industrial activity. This can only be done by the substitution of farm machinery for the work now being done by hand labor. After all, agricultural or industrial relief cannot be made permanent unless ways and means are developed to effectively meet competition.

Accident Hazards in Agriculture

By R. L. Forney[1]

IN A special accident statistics bulletin issued by the Nebraska Press Association, for the two weeks' period ending August 13, 1929, it was stated that "farm employment produced more than twice as many accidents as industrial employment for the state of Nebraska during this period." This period of two weeks resulted in 31 injuries, 5 permanent disabilities and 4 deaths. Fourteen of these accidents were caused by farm machinery, 11 by farm animals, 8 by falls, and 7 by sprains, infections, cuts and burns. In the 5 accidents which caused permanent disabilities, three farmers lost their fingers and two each lost an arm.

As a comparison which is quite favorable to agriculture, during the same period of two weeks there were reported for the state of Nebraska 49 home accidents, 36 other public accidents, and a total of 159 motor-vehicle accidents. Nebraska of course is classified as an agricultural state, and this was during the period of year when farm accidents were probably at their height.

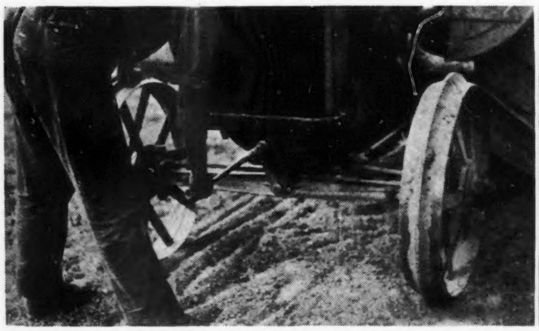
A like interesting study in agricultural accident hazards is afforded by the accident report of the Kansas State Board of Health for the year 1929. This report classifies in detail 22 deaths from non-automobile vehicular accidents, 18 of which were caused by farm wagons, and 6 of which were equipped with hayracks. In contrast it should be mentioned that there were a total of 380 deaths in Kansas during the year from automobile accidents.

During the same period, 25 fatal injuries were caused by animals on farms or in other places; 11 of the persons killed were under 15 years of age. Nine of the fatalities resulted from kicks by horses, two from kicks by mules, and 6 from falls from horses. There were 37 deaths from electricity, 8 of which were from lightning. One of these victims of lightning was in a barnyard, and four others were at work in fields. During the year there were also 83 accidental drownings, 5 of which were to persons who slipped or fell into stock-watering tanks.

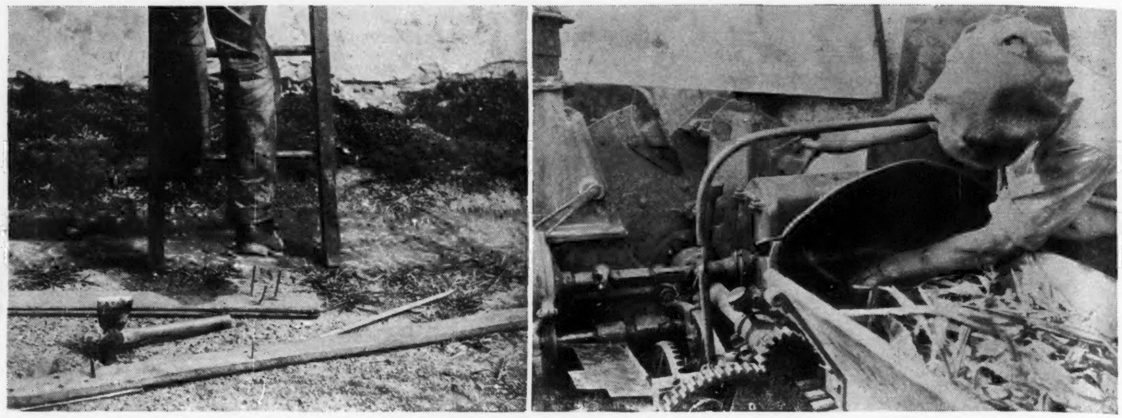
In comparison, during the year there were in Kansas 49 deaths from machinery, at least 30 of which were specifically from farm machinery. It is interesting to note that 16 of these deaths were from tractor accidents. Three deaths were caused by threshing machines; and two deaths each from mowing machines, hay balers, headers, and combines. In addition, there was one accidental death each from a disk harrow, a manure spreader, and a binder.

The 16 accidents by tractors were caused as follows: 6 occurred as the result of tractors overturning, 5 occurred as the result of falls under wheels, 2 occurred while making a hitch with other machinery or vehicle, 1 while cranking a tractor, 1 from an explosion while filling a tractor tank, and one from a fall across a steering wheel.

[1]Statistician, National Safety Council.



The use of internal-combustion engine power on farms, and the handling and storage of fuels required in its operation, has, along with the great benefits it has brought to the agricultural industry, introduced certain accident hazards, against which it is essential to provide proper safeguards. The job of developing the necessary safety means for offsetting these hazards is largely that of the agricultural engineer



The agricultural engineer may well give much more attention than he has thus far to ways and means of preventing farm accidents. As this task is to a considerable extent of an engineering nature, the engineer has an important responsibility in connection therewith

Interesting agricultural accident facts also have been assembled for the year 1928 by the industrial commission of Wisconsin. This report affords a partial contrast study of distinct farm machinery accidents and industrial machinery accidents, since the 1920 population statistics show that these two groups were about equal in number, namely, near the 300,000 mark. But this comparison is only partial, because Wisconsin farmers are not subject to the operation of the state compensation law unless they so elect in writing or by securing a policy of insurance. Hence, it is probable that a considerable number of injuries from farm machinery were not reported to the state industrial commission. This would include injuries to individual farmers or members of their families.

This report tabulates a total of about 3,000 injuries from machinery for 1928 which were awarded compensation. Only 145 of these accidents were from farm machinery. This total, however, represents a decided increase over the year 1927, which had only 114 compensable injuries from farm machinery.

In contrast with these 145 injuries from farm machinery, there were 734 injuries in the state charged to woodworking machines, 1,139 charged to metal working machines, and 18 charged to dairy products machines.

It is interesting to note, in exact correspondence with the like accident reports from both Kansas and Nebraska, that a high percentage of these reported injuries—namely, 88 out of 145—were caused by tractors. In addition, 26 injuries were caused by threshers, 9 by such hay tools as forks and loaders, 5 by corn shredders, 3 by harvester binders, 1 by an ensilage cutter, and 13 by other farm machines.

The reports from these three agricultural states would seem to indicate that accident hazards from the use of agricultural equipment are serious enough to deserve careful attention, in the interest of agricultural engineering efficiency and life conservation.

The hazard from threshing machinery seems most serious. This is probably because belts on threshing machines are seldom guarded, because of the natural hazards at the intake of the machine, and because some of the steam and gasoline engines which afford power are substandard. The remedy would seem to be a more careful checking of all such equipment from the viewpoint of safety, more watchfulness on the part of the overseers of harvesting labor, and a program for the development of individual personal habits of safety.

It has been said that industrial accident hazards in this country originated with agriculture. The beginning days of agriculture were typified by crude production methods and by a great variety of accident hazards, since the average farmer was called upon and still is called upon to do many different things.

It has been proved many times, in the manufacturing industries, that accident prevention and efficiency results are closely associated. For this reason, industry has given considerable attention to the development of special machinery to eliminate mechanical hazards, safety equipment for machines, and highly organized safety methods among employees.

In contrast, some agricultural machinery has not been so thoroughly equipped with safety devices, although more and more attention is being given by the manufacturers to inherently safeguarding machinery at the source. Farmers have not realized the value of safety equipment, and therefore have not systematically insisted upon it.

Statistics are not available, but it has been stated that the greatest hazard on the farm, as is true both in our factories and our homes, is from falls. This hazard is increased on the farm because of so many mingled farm activities, much moving machinery, and the necessity of climbing about a great deal on ladders and otherwise. There is always a hazard when hand tools are used carelessly; and in the careless use of such hand-operated equipment as feed cutters, grinders, winnowing machines and corn huskers. Even a grindstone may become a hazard, especially if connected up, for example, with mechanical motive power.

There is always a hazard from machinery driven by power, unless careful attention is given to belts, to the protection of gears, to proper release levers, and to equipment designed for the quick stopping of such machinery.

There are many records of injuries from such simple operations as plowing, harrowing, and mowing. These may be caused by lack of attention when rocks or roots may be struck, through falls, through runaway teams, and through carelessness with motive machinery for such implements.

Tractor engines and combines have brought new hazards to the farm. Also trucks, power pumping, electric plants, and all kinds of motive machinery.

Still another new hazard is from carbon monoxide through the exhaust of gasoline engines used in enclosed places. The storage and the use of gasoline and oil are new farm hazards. Many times on a farm the steam boiler is so neglected and exposed as to deteriorate rapidly. There are many instances, for example, where safety valves have been found fastened or rusted down. Even the farm windmills, when the ladders are permitted to weaken, may become a real hazard.

In this day of the increasing use of mechanical equipment on farms, consistent attention should be given to the safety of such equipment.

Suggestions on Extension Programs in Rural Electrification[1]

By C. E. Seitz[2]

THE purpose of cooperative agricultural extension work is to disseminate information gained, first, through research and investigations by state agricultural colleges and experiment stations and the federal department of agriculture, and, second, through results obtained by the best farmers and homemakers. Information thus obtained is made available to all farmers and farm women in order that methods and standards of living on the farm may be improved. Agricultural extension work consists of giving instruction and practical demonstrations in agriculture and home economics to persons not attending or resident in colleges, and imparting to such persons information on said subjects through field demonstrations, publications, meetings, short-courses and otherwise. Instruction in many subjects is being given in agriculture and home economics through cooperative agricultural extension work.

Extension work has in a thousand ways modified farm practices to the individual benefit of the farmer. It is placing at the farmer's disposal a better organization of facts by means of which he is doing more accurate thinking, reaching safer conclusions, and living a more satisfactory life.

It is the duty of the agricultural extension service to make available as rapidly as possible the results of research and experimental work, or the results of demonstrations that will aid the farmer in improving his conditions. The research and experimental work in adapting electric power to farming operations, which has been in progress in many states, has developed many profitable farm uses of electricity and demonstrated beyond a doubt that electric power, when available at reasonable rates, if properly used, will reduce labor and production costs on the farm, shorten the farmer's hours of work and give greater opportunity for leisure and enjoyment to himself and family. It is therefore of the greatest importance that extension education in farm electrification be made available to farmers as rapidly as possible.

Farm electrification in its broadest sense means more than the use of electric lights in the farm home. It means the intelligent use of electric power in all farm and home operations that can be handled more efficiently and at less cost by electric power than with other forms of power.

It is estimated that at least 550,000 farmers in the United States had electric service from power companies at the end of 1929. Electrical authorities predict that by 1933 at least 1,000,000 farms will have electric service, and that by 1938 there will be 3,000,000 farms connected to high-line electric service.

Some idea of the magnitude of rural electrical development may be gained from the following figures. It is estimated on reliable authority that at least $195,000,000 was invested in farm electric distribution lines up to 1928. To electrify the 3,000,000 farms predicted by 1938 will involve over $1,000,000,000 invested in electric transmission lines alone. Add to this about $800 as the average investment on each farm for wiring and electrical equipment, or $2,400,000,000 for the 3,000,000 farms, and we have the enormous amount of $3,400,000,000 as an estimated cost of transmission lines, wiring and equipment. It is evident that farm electrification is a stupendous undertaking.

Standard state-wide plans are being worked out in many states for the extension of farm electric lines. These plans will speed up the construction of farm electric lines. If farm electrification is to be placed on a profitable basis, both to the farmer and the power company, farm lines must be designed and constructed to provide adequate, dependable and economical service. And a large amount of educational work must be done.

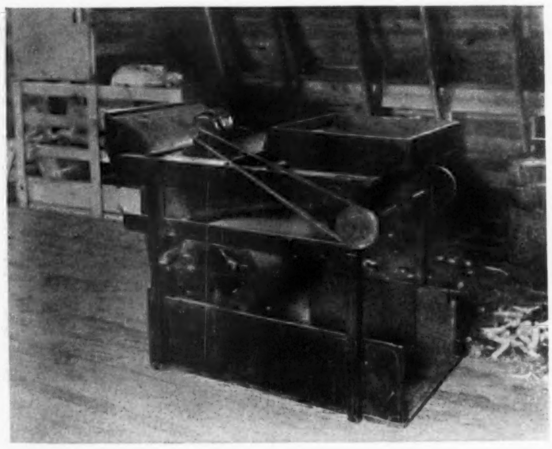
Information on the use of electricity in agriculture collected at the various agricultural colleges must be made available to the farmer and utility as rapidly and as effectively as possible. The dissemination of this information is clearly extension work and the agricultural extension services in all states should make provision for extension work in farm electrification.

Farm electrification is still in the pioneer or development stage in most states. The electrical interests as well as the farmers are looking to the colleges for guidance and direction in the multitude of problems involved. Some states are now doing effective extension work in farm electrification. Such states have found that great good can be accomplished through extension education in this subject.

For example, in Michigan effective work has been done by the farm electrical extension specialist in the matter of proper wiring of the farmstead which is one of a number of important problems involved in farm electrification. To June 1928, 85 per cent of the farmsteads in Michigan receiving electric service were wired with too small a service to be of real value. Since June 1928, 3000 farm customers have received electric service for the first time; 98 per cent of these new farm customers have wired their

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Rochester, N. Y., October 1930. The suggested extension project in farm electrification outlined in this paper is sponsored by a special subcommittee on rural electric extension of the main Committee on Extension of the American Society of Agricultural Engineers, the personnel of which is C. E. Seitz (chairman), agricultural engineer, Virginia Polytechnic Institute; W. C. Krueger, agricultural engineer, Rutgers University; H. J. Gallagher, agricultural engineer, Michigan State College; R. R. Parks, agricultural engineer, University of Missouri; J. P. Fairbank, agricultural engineer, University of California; J. P. Schaenzer, agricultural engineer, University of Wisconsin, and T. E. Hienton, agricultural engineer, Purdue University.

[2]Professor of agricultural engineering, Virginia Polytechnic Institute. Mem. ASAE.



This installation consists of a fanning mill being driven by a ¼-hp General Electric split-phase motor

homes for electric service, as a result of extension educational work.

The fact that wiring inspection is not generally required in rural districts, together with the farmer's lack of knowledge of wiring requirements, has enabled unscrupulous electrical contractors to take advantage of the farmer. The sale of electrical equipment unsuitable to efficient and economical operation on the farm is often promoted. It is highly important that proven electric power equipment for the farm be properly installed for automatic or semi-automatic operation.

To this end farmers, implement dealers, manufacturers of electrical equipment, and electrical company employees should be given educational information. Organized extension education is necessary to guide the various groups concerned while the development of rural electrification is still in its infancy. Here is an opportunity for extension work to render a real service in the pioneer stage of an important development that will prove invaluable to agriculture.

The extension specialist in farm electrification should work through the regular county farm and home demonstration agents, farm organizations, etc., so that the projects may be largely conducted on the same basis as all other extension projects. Full use should be made of all cooperative agencies in furthering the farm electrical project, such as the U. S. Department of Agriculture, the Committee on the Relation of Electricity to Agriculture, the National Electric Light Association, the American Society of Agricultural Engineers, farm organizations, other college and extension divisions, power companies, equipment manufacturers, agricultural high school teachers, implement dealers, merchants, bankers, etc.

Assuming that there is a definite and urgent need for educational work in farm electrification, in order that the farmer may make full and intelligent use of electric service, a special subcommittee on rural electric extension of the main Committee on Extension of the American Society of Agricultural Engineers suggests the following general outline for an extension project in farm electrification, in the hope that it will be of some aid to extension specialists considering such a project:

I. PROJECT

Electricity on the Farm

II. OBJECT

To improve living conditions on the farm by reducing the drudgery and labor of house work and by reducing labor and production costs in the farm business; to improve the quality of farm products, and to make possible the more efficient management of the farm business by assisting the farmer with such electrical problems as

1. Getting electric service to the farm
2. Properly wiring farm buildings so the full value of electric service can be realized
3. Familiarizing farmers with the proper application of electrical equipment to farming operations, and aiding in the selection of suitable equipment
4. Familiarizing farm women with new, proved equipment and with more efficient operation of household equipment, proper principles of lighting the home, etc.
5. Cooperating with commercial interests to insure high business standards in farm contacts.

III. IMPORTANCE

Thousands of farms in America are now receiving electric service and in the next few years many thousand additional farms will secure this service. Investigations and research conducted in over twenty states have demonstrated that when intelligently used electric power will materially aid in reducing labor and production costs and improve living standards in the farm home. It is of the greatest importance that the results of these studies in

Shelling corn with a ¼-hp Westinghouse split-phase motor

electrical application be presented to the farmer in a way that he can make the best use of them.

As the ultimate objective of all extension work is the improvement of living standards on the farm, and since electricity is an important means towards securing this objective, it is essential that the farmer and other groups concerned be guided by means of extension education, particularly while farm electrification is still in the pioneer or development stage.

IV. PLAN OF WORK

To present to farmers the results of research and experimental work in electrical principles and uses in agriculture, the following means of presentation are suggested:

1. Annual meetings, schools, conferences or short-courses for rural service men and others from electric light and power companies. (It is believed that one of the most effective methods for the dissemination of information on farm electrification is through the holding of an annual meeting at the state agricultural college for rural service men at which recent developments in rural electrification, new equipment and experimental results may be presented. This follows to a considerable degree the idea used in extension work of training local leaders who return to their own communities and in turn present work which has been presented to them by the specialist.)
2. Annual meetings, schools, conferences or short-courses for farmers, farm women, and boys and girls 4-H Clubs. (The regular annual farmers' institutes, institutes of rural affairs, farmers' day, farmers' week, field days, and boys and girls 4-H club short courses, encampments, etc., also offer a splendid means of presenting farm electrification information. Every effort should be made to give instruction at such meetings. One-day schools on special

subjects such as silo filling are very effective methods of instructing on specific uses.)

3. Demonstrations in cooperation with county agents of specific uses on farms, showing practices of outstanding value that are of immediate application and of community or general interest. (It is believed that rather than the selection of a few demonstration farms, the selection of a number of special demonstrations on different farms will prove more effective, secure the interest and cooperation of more farmers, and be more in line with established methods of extension demonstrations. Farmers learn by observing what their neighbors do. By securing the cooperation of farmers for demonstrations of specific uses of electrical equipment, considerable good can be accomplished. Demonstration equipment should be provided with check meters so that the farmer himself may tell others the exact cost of operating the equipment. Such demonstrations may be used satisfactorily for county meetings, tours, etc., at which individual pieces of equipment may be demonstrated. In arranging for such demonstrations on farms, the extension specialist should have the cooperation of the local county agent and his extension organization in the county, the local power company, and the equipment dealers concerned.)

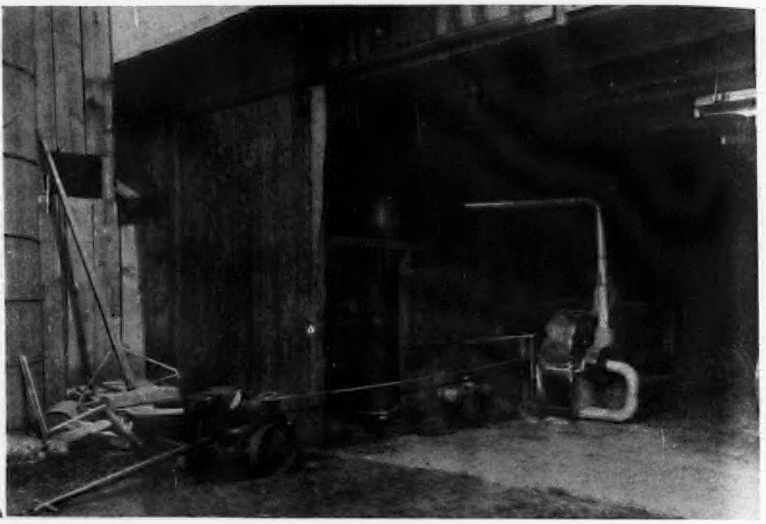
4. Bulletins, circulars and handbooks on farm electrification. (While bulletins, circulars, handbooks, etc., are not as effective as the two previously mentioned means, they should be made available in greater numbers than they have been up to the present time. General bulletins on wiring and lighting supplemented by bulletins on farm electrical equipment should be available for an extension program. These bulletins to be the most effective should be issued by the college in which the extension specialist is working.)

5. Publicity through local papers, the farm press, radio talks, and talks before community and county agents meetings. (Publicity through local papers and the farm press is of primary importance in connection with the farm demonstrations. By local publicity the results which are being obtained on these farms can be made known to the whole community. While this local publicity is usually best accomplished through the rural service man of the power company, or the county agent, or both, it usually devolves upon the extension specialist to furnish the write-up of the material. Stories of general interest on farm electrification are usually welcomed by editors of farm papers. Talks at local meetings and radio talks serve to supplement the other items already listed. Radio stations are welcoming worth while discussions of material which is of interest to farmers. Many colleges are establishing radio stations and the opportunity of using the radio is growing rapidly. Local talks on the value of farm electrification frequently aid communities in getting together to foster the building of electric lines. County agents are becoming more interested in farm electrification and welcome talks of this kind.)

6. Short-courses or schools in cooperation with vocational school instructors both for students and adults. (Schools held under the auspices of Smith-Hughes high school agricultural instructors and others offer a splendid field for advancing farm electrification information. Such schools have been generally successful in states where they have been tried. The farm electrification specialist should hold one such school with each instructor or a general training school for vocational teachers before the vocational teacher attempts to hold such a school. Detailed courses, including aids and references in farm electrification for farm boys not in school and adult farmers, should be prepared by the specialist. At these courses it is advisable to discuss and possibly demonstrate some piece of electrical equipment. Advantages and growth of farm electrification, local rates, extension policies, wiring the farmstead, lighting equipment, farm motors, water supply, feed grinding, silo filling, milking machines, dairy refrigeration, poultry lighting, brooding and incubation, household equipment, etc., are suggested topics for discussion at these meetings. The local utilities, manufacturers and dealers will usually assist with such schools by loaning equipment, supplying speakers, moving pictures, etc.)

7. Exhibits at state and county fairs, fields days, etc. (Farm electric exhibits attractively displayed at state and county fairs, field days, farmers' institutes and other farm gatherings are a valuable means of creating interest or getting across a specific piece of instruction. It is believed that, rather than make farm electric exhibits of a general nature, much more good can be accomplished by concentrating on one or two specific uses of electricity on the farm. It has been pretty well proven in practice that the extension exhibits that do the most good or accomplish the best results are those that endeavor to get across one main idea, or teach one important lesson. In other words, the successful exhibit is arranged to attract attention and to tell the story briefly, so that the whole idea may be grasped at a glance.)

The silo filler in this picture is being driven by a 5-hp General Electric motor of the repulsion-induction type. The electric motor has proven a most satisfactory source of power for operating silo fillers, and its use for this purpose is rapidly increasing



One of the most extensive uses of electric motors in agricultural operations is for driving feed grinders. In this particular installation a 5-hp Westinghouse portable motor of the squirrel-cage, induction-starting type is furnishing the power. The starter is contained in the box attached to the motor

8. Organized county agent service on specific group problems, such as water supply, dairy refrigeration, poultry uses, etc. (There are many organized county agent projects already functioning that can be used effectively to demonstrate the advantages of electric power. Whenever possible the electrical specialist should cooperate with the specialist handling these projects, if electric power can be used to advantage in the successful conduct of the project. For instance, in such projects as dairy refrigeration, dairy equipment, stationary spraying of fruit, fruit and vegetable cold storage, farm water supply, poultry equipment, etc., there is an opportunity for effective cooperation between the farm electrical specialist and the specialists handling the various projects. It should be the duty of the farm electrical specialist to see that on these organized projects the proper use is being made of electric power where available. In this way the electrical specialist may be of considerable assistance to other subject matter specialists.)

V. ORGANIZATION

For best results in handling this project there should be at least one full-time extension specialist in rural electrification. Preferably this specialist should be a professional agricultural engineering graduate. He should at least have a thorough grounding in fundamental engineering and agriculture; have a thorough understanding and sympathy with agricultural problems, and be able to talk to the farmer in his own language. He should have an understanding of sound economic development; be familiar with the research and experimental work being done in his field, and should be an educator and not merely a promoter.

The cooperation of other divisions of the state college, extension service and experiment station is desirable in carrying on a successful extension program as most every department of the agricultural college, is concerned in some phase of this work.

The cooperation of the county agents, home demonstration agents, vocational teachers, farm organizations, power companies and equipment dealers is essential for best results.

VI. THE SPECIALIST'S DUTIES

The specialist's duties are to work in cooperation with county agricultural agents: (1) By furnishing the agent with complete instructions on methods of handling this project and by supplying bulletins and other educational matter for distribution and publicity purposes, (2) by securing cooperation of electrical power and equipment companies, (3) by attending meetings and discussing farm electrification problems, (4) by keeping county agents and farm service men informed on farm electrification developments at county agent conferences, at farm electrification conferences, and through correspondence, (5) by assisting in the selection of proper demonstrations on farms in the county, and (6) by collecting, correlating, analyzing and distributing data available from demonstrations.

VII. COUNTY AGENT'S DUTIES

The county agent's duties are to arrange with the extension specialist for educational work on farm electrification: (1) by selecting farms for demonstrations, (2) by organization of farming communities to receive electric service, (3) by organization of farm clubs on farm electrification, (4) by publishing the results of work in short news items in local papers, (5) by advertising through newspapers and correspondence all meetings, etc., and (6) by assisting in follow-up work in order to check results and measure progress.

VIII. COOPERATOR'S DUTIES

The farmer selected for a demonstration will agree to follow instructions, allow meetings on his farm, keep records, and cooperate generally in making the demonstration worth while.

The local power company will cooperate by furnishing and installing check meters and assisting in every possible way in carrying on the demonstration.

The equipment dealer, or equipment manufacturers, will cooperate by advising on the installation and operation of equipment, and in special cases, when justified, loan equipment for demonstration purposes.

IX. OTHER COLLEGE DIVISIONS

Other divisions of the agricultural colleges directly concerned will cooperate by furnishing technical information and assistance, and when practical supply a specialist to conduct demonstrations.

X. MEASURING RESULTS

The results of the farm electrification project may be measured by: (1) Number of farms securing electric service, (2) increase in use of current on farms, (3) savings effected by use of electricity over old methods, (4) electrical equipment installed, (5) number of farms reached by specialist, (6) improvement in living standards on the farm, (7) number of educational meetings held, (8) number of people in attendance or reached, (9) results of demonstrations on farms, and (10) increased income resulting from use of electricity, etc.

Observations on Trials of a New Type of Small Grain Harvester[1]

By A. J. Schwantes[2]

THE new type of grain harvester described in this paper has been under observation by the Department of Agricultural Engineering of the University of Minnesota the past season. It is a machine that is built very much like the grain binder, except that a circular tank about 7 feet in diameter and about 6 feet high replaces the binder head. It has a cutter bar that is 12 feet wide and is adjustable for height. The machine is made according to two different designs. In one case the power to operate the cutting and stacking mechanism is taken from the bullwheel by means of drive chains, as is done in the horse-drawn grain binder. In the other type, this mechanism is driven by means of a power take-off from the tractor.

The power of a three-plow tractor is required to haul the machine in the field. The recommended rate of travel is about the same as that of the grain binder or combine. The capacity per unit of time with this new type harvester would be about the same as another type of harvester having the same width of cut. It is estimated that a normal rate of harvesting under average conditions would be about 25 or 30 acres per day.

The machine cuts the standing grain and assembles it in the form of stacks. The grain is not bound into bundles, but, as it is cut, it is deposited with the heads toward the center in the circular tank. The base of the tank revolves. As the tank becomes filled, the grain is compressed by means of a cone-shaped compressor which is situated in a horizontal position at the top of the tank. The base of the cone is located near the wall of the tank and the vertex of the cone is located near the center. It is free to revolve and is attached by means of a swivel joint which allows it to raise as the stack grows lighter. When enough grain has been deposited in the tank to make a stack, the rear half of the tank automatically raises, and the stack is deposited on the ground.

The operator controls the position of the conveyor which drops the grain into the tank. Thus he may build a good stack or a poor one, depending on his experience and on his attention to the business at hand. The center of the stack must be kept well filled while it is being built. The center should be built up higher than the sides as the stack is being finished. It is possible to build a stack that is compact, that will stand up well and that will shed water.

The grain is allowed to remain in these stacks until it has become sufficiently dry for threshing. The time necessary to accomplish this is probably somewhat longer than the time required for curing in the shock. It will also depend on weather conditions and on the stage of ripeness at the time of cutting. A week or ten days probably is the lower limit under ideal conditions. Data contained in a report of the division of agricultural engineering of the North Dakota Agricultural College would indicate that the stacks may stand for several months under normal conditions without serious danger of affecting the quality of the grain.

To facilitate threshing the stacks are assembled in a central location. This is done by means of a buck-rake operated with a team or a tractor. A buck-rake will handle one complete stack. The stack is picked up just as it stands and is hauled to the point of assembly where it is again deposited with very little disturbance.

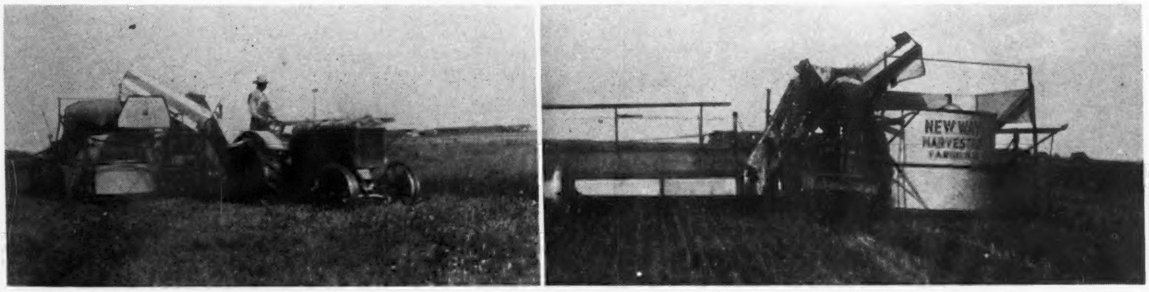
The work of assembling the stacks may be done at any time between cutting and threshing. It ordinarily does not interfere with the curing process. If the stacks have been assembled previously, only one or two teams are required to bring them close to the separator at threshing time. The threshing machine should be equipped with wide feeder wings, and they should be long enough so that they may be let down to the ground.

This method of harvesting is relatively new. It has been used some in North Dakota for the last three years and was reported on briefly by the department of agricultural engineering of the North Dakota Agricultural College at the close of the 1929 harvest season. It has been used on at least two Minnesota farms during the harvest season. The obvious advantages of this method over the use of the binder are the elimination of the cost of twine and the labor of shocking Because it is new, many questions arise as to its feasibility under Minnesota conditions. An attempt was made during the 1930 harvest season, under the author's direction, to arrive at an answer to some of the problems which present themselves in connection with its use in Minnesota. Data were obtained on a farm in Renville County where most of the small grain crop was harvested in this way. On all of the fields, however, part of the crop was cut with the binder and threshed from the shock. This made possible the comparison of the two methods in some respects.

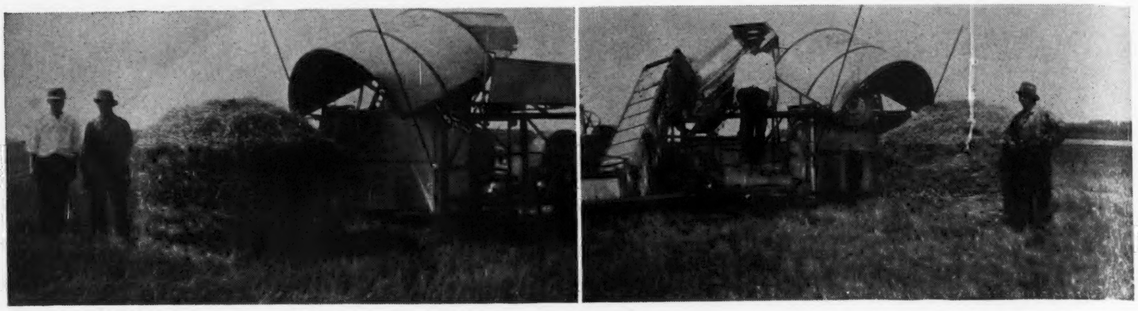
The data which are presented here are the results of observations on only one farm and for one season only.

[1]Paper No. 227, Miscellaneous Journal Series, University of Minnesota. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Professor of agricultural engineering, University of Minnesota. Mem. ASAE.



Front and rear views of the New Way Grain harvester as it was under observation the past season by the agricultural engineering division of the Minnesota Agricultural Experiment Station



When the tank of the New Way harvester is full, the rear half automatically opens, and the stack is shoved off the platform onto the ground

It must be remembered that the 1930 harvest season was unusually dry and hot. Only one rain occurred between the time the grain was cut and threshing time. The amount of moisture which fell was so small that its effect was negligible. Under these conditions no difficulty would be experienced in curing grain preparatory to threshing regardless of what method was used.

The small grain acreage on the farm where the data were obtained together with the yield are shown in Table I.

The harvesting of crops on this farm was done at about binder harvest time. The moisture content of crops at time of cutting with the binder varies a great deal. It is usually between 20 and 30 per cent, but sometimes gets lower than that.

In our observations the Marquillo wheat had a relatively high moisture content at time of cutting. While no moisture determination was made of the straw, it is assumed that it contained more moisture than the grain at time of cutting. The transfer of moisture from the straw to the berry occurred for several days after cutting at a more rapid rate than the loss of moisture from the berry, and, consequently, its moisture content went up. A total of about 15 days were required for the moisture content of the Marquillo to get down to 14 per cent which is about the upper limit for safe storage.

The Marquis was dead ripe at the time of harvesting and apparently very little change took place while the grain was in the stack.

Because there were no rains, it was impossible to determine to what extent the stacks will shed water and how rapidly they will dry out again if they should become water soaked. It is supposed that they would be less susceptible to soaking than ordinary shocks, but, on the other hand, it seems reasonable that a relatively long period of favorable weather would be required to dry them out again.

The weight per bushel and moisture content are two important factors of quality of grain; Table II gives these data for the different grains at threshing time.

It is interesting to note that the test weight of all crops except barley is higher for grain from stacks than from shocks. The probable explanation for this is that grain in shocks was subject to alternate wetting and drying caused by dews which results in a lower test weight. There is a direct relationship between moisture and test weight. As the moisture content increases, the test weight decreases. A sample of grain that is exposed to alternate wetting and drying is subject to an expansion and contracting of the kernel as a result. After a number of such fluctuations, the berry refuses to contract to its original size when it becomes dry and consequently, the test weight remains low. Grain in stacks made by this new type harvester would not be subject to such frequent wettings caused by dew or light rains.

The moisture content of grain from stacks was slightly higher in each case than it was for grain harvested with the binder. This is probably due to the fact that the shock grain was more directly exposed to wind and sun. The difference in moisture content is not sufficient to materially affect the relation between the test weights. The tendency of the existing difference in moisture content would be to increase the spread between the test weight of grain from shocks and from stacks.

Samples of wheat, oats and barley from shocks and from stacks were examined by specialists in agronomy (Dr. H. K. Wilson) and cereal chemistry (Dr. C. H. Bailey) at the Minnesota Agricultural Experiment Station. These men expressed the opinion that, so far as color and general appearance were concerned, there was no significant difference between the samples which represented the two methods of harvesting.

The division of agricultural biochemistry of the Minnesota Station made a milling and baking test on a sample of Marquis wheat taken from the stacks made by this harvester, and on a sample from the same field that was cut with the binder and threshed from the shock. The sample from the stacks produced a flour yield of 70.2 per cent; the flour yield of the sample from the shocks was 73.0 per cent. The results of this test are interpreted by Dr. C. H. Bailey as follows: "The difference in milling yield is in favor of the binder-harvested sample and is probably large enough to be significant, although the probable error of a single milling sample is fairly large. The baking tests (conducted in quadruplicate) fail to reveal any significant differences between the two lots of flour either in color or in baking strength as disclosed by the size (loaf volume), texture, or grain of crumb of the resulting loaves."

An important factor in the consideration of a new method of harvesting is the efficiency of the method from the standpoint of recovering all of the crop. The cutting

Table I. Acreage, Yield and Number and Size of Stacks

Crop	Acres	Bushels per acre	Number of stacks	Stacks per acre	Bushels per stack
Winter wheat	20	41.5	108	5.4	7.7
Marquis	10	16.0	51	5.1	3.1
Marquillo	10	17.0	40	4.0	4.2
Barley	14	37.0	75	5.4	6.9
Oats	43	53.6	315	7.3	7.3
Flax	22	13.9	110	5.0	2.8

Table II. Test Weight and Moisture Content

	Test Weight (pounds per bushel)		Moisture Content (per cent)	
	Stacks	Shocks	Stacks	Shocks
Winter wheat	60.0	58.0	13.2	10.6
Marquis	58.0	55.0	12.0	10.7
Marquillo	56.0	54.0	12.6	11.1
Barley	43.5	47.0	13.5	12.1
Oats	35.5	33.5	13.3	13.1

Table III. Harvesting Losses

	Cutting losses		Losses beneath stacks		Total losses	
	Pounds per acre	Per cent	Pounds per acre	Per cent	Pounds per acre	Per cent
Winter wheat	30.60	1.2	3.1	0.1	33.7	1.3
Marquis	22.00	2.3	2.8	0.3	24.8	2.6
Marquillo	40.60	4.0	2.3	0.2	42.9	4.2
Barley	81.25	5.7				
Oats	22.00	1.3				

operation with this new harvester is very similar to that of the binder, and, consequently, the cutting losses would be expected to be about the same. Since the grain is dropped into a tank when it reaches the upper part of the conveyor, there is no opportunity for loss of grain at that point as there is in the packing and tying operation of the binder.

The amount of grain that was not picked up by the harvester, or that was lost after it had been picked up, was determined on the fields of wheat, barley and oats. The procedure that was followed on each field in making this determination was as follows:

Several areas, each of which was 100 square feet in size, were selected at random. All of the heads in each area were picked up. The heads thus recovered from each field were threshed and the grain was weighed. From these data it was possible to calculate the loss in pounds per acre. The percentage loss is based on the yield per acre as determined at threshing time.

The data showing the losses are given in Table III. These losses compare favorably with cutting losses that result from the use of the combine and are lower than similar losses that usually result when the binder is used.

An important factor contributing to the relatively high loss of barley is that part of the field was badly lodged, and consequently many of the heads could not be picked up. It is questionable if a better job could have been done with another type of harvester. The average cutting loss from 45 combines in Minnesota during the 1930 harvest season was 3.6 per cent. This includes wheat, oats, rye, barley and flax and represents machines from practically every section of the state where combines are used. Binder losses are usually larger because of the additional opportunities for such losses in the process of packing and tying the bundle.

An additional possibility for losses by this new harvesting method occurs in grain that is left on the ground at the location of the stack when it is moved. Determinations of these losses were made on the three wheat fields and the data are also shown in Table III. All of the grain that was left at a location previously occupied by a stack was recovered from several representative locations in each field. The grain thus recovered was threshed and weighed. Thus the average loss per stack was determined. Knowing the number of stacks in each field, and also the acreage and yield, it was possible to determine the number of pounds per acre that was lost in this way as well as the percentage loss.

This loss appears to be relatively insignificant. It must be remembered in considering the losses caused by the harvester and those at the stack locations that all of the determinations were made on one farm, the machine was operated by an experienced operator, and special care was doubtless exercised to do a creditable job of harvesting and moving the stacks. On the other hand, the data obtained demonstrate the possibilities of doing a relatively clean job of harvesting with this method.

A Ten Thousand Barrel Farm Apple Storage Plant[1]

By C. F. Mowrey[2]

AN INTERESTING and unusual type of apple storage plant located on the Hitchings Fruit Farms at South Onondaga, twelve miles south of Syracuse, N. Y., is now in its third year of satisfactory operation. It was designed for the packing and keeping of quality apples with a minimum of wastage and with a low investment and operating cost.

The building is 102 feet long, 72 feet wide and about 25 feet high. Inside dimensions of the storeroom proper are 70 feet by 70 feet by full height. A packing room at one end is 70x30x12 feet. The room above serves as a storage for paper cartons which are fed through wooden chutes to the packers on the floor below. A small office is built into one corner of the shipping room adjacent to a small loading platform in the front of the building. A 9-foot loading platform runs the entire length of the rear of the building.

There are five large doors in the plant. Two 4-foot storage doors lead from the packing room to the storage room and one from the large loading platform to the storage room. It has been found that 4½ or 5-foot doors would be more satisfactory. A 4½-foot door leads from the packing room to the large loading platform at the rear of the building and one to the small platform at the front.

[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Rochester, New York, October, 1930.

[2]Refrigeration engineer, Syracuse (N.Y.) Lighting Company.

A front view of the storage, showing the small loading platform and the door to the shipping room. Note also the absence of windows in the storage part of the building, and the pilasters which reinforce the wall under the ends of the horizontal roof beams

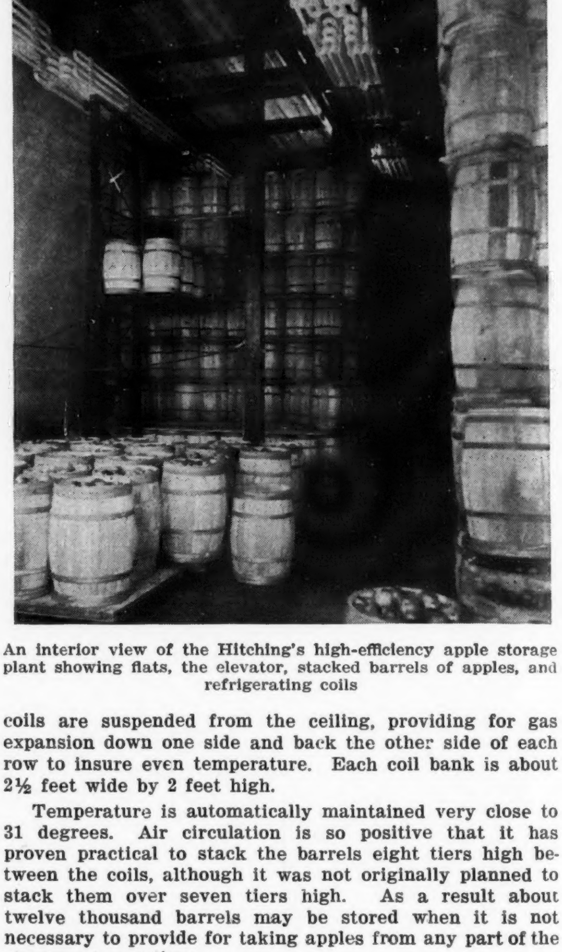
The refrigerating machinery is in the packing room near the storage room wall and coils are suspended overhead in the storage room.

Barrels are not headed before storing in this plant, thus preventing the bruising of apples near the top of the barrel. Packed barrels are placed upon a low platform called a flat which holds six barrels. These flats are eight inches high, the height of the curbing at the edge of the large loading platform. A hand truck is wheeled under the flat and then raised to its high position. The six barrels of apples are wheeled into the storage and rolled onto a portable elevator which holds just six barrels. They are then elevated to the proper height and rolled off. Each tier of barrels supports the next tier by means of 1x6-inch boards placed along the edges. In this manner the barrels are stacked seven or eight tiers high, depending upon their proximity to the coils.

The walls of the building are of 8x8x16-inch cement cinder blocks which were used because they have some insulating value, will not draw moisture, are resistant to cracking and will hold driven nails securely. The blocks were faced on the inside of the storage room and 4 inches of cork-board dipped in odorless asphalt was applied to the walls in two layers of 2-inch slabs. The walls were then faced with two layers of 2-to-1 cement. The second layer was marked off in 2-foot squares to prevent checking. One layer of 3-inch corkboard was laid in asphalt on a concrete subfloor and was then covered over with a 3-inch concrete wearing floor. Eight structural steel columns support the roof. The outer ends of the horizontal beams rest on the walls at points braced by 16x24-inch cement cinder block pilasters on the outside of the walls. Two-inch plank roof boards are nailed to two-by-fours bolted to the roof perlins. Five inches of corkboard is laid in asphalt over the roof boards and covered by a slag roof. There is about one foot slope across the roof. The corkboard is applied in such a way that the wall corkboard comes in good contact with the roof corkboard and the floor corkboard, thus preventing heat leakage at these junctions. Ordinary practice was followed in building the concrete foundations for the walls and columns.

In order to complete the building picture, several items must be mentioned. Both loading platforms are protected by low roofs bolted to the walls and supported by iron posts. There are no windows in the storeroom but quite a number in the packing room. A small cement cinder block chimney serves as a flue for the small stove in the office. Two lightning rods and a metal eaves trough complete the roof decorations.

The refrigerating equipment is of twenty-ton capacity but has been set to operate at fifteen tons capacity, the reserve being for future expansion. Six double rows of



An interior view of the Hitching's high-efficiency apple storage plant showing flats, the elevator, stacked barrels of apples, and refrigerating coils

coils are suspended from the ceiling, providing for gas expansion down one side and back the other side of each row to insure even temperature. Each coil bank is about 2½ feet wide by 2 feet high.

Temperature is automatically maintained very close to 31 degrees. Air circulation is so positive that it has proven practical to stack the barrels eight tiers high between the coils, although it was not originally planned to stack them over seven tiers high. As a result about twelve thousand barrels may be stored when it is not necessary to provide for taking apples from any part of the storage at any time.

Considering that this plant has proven to be an exceptionally good investment, there is reason to believe that there is need for many more farm cold storage plants.

Table I. Results of Blanket Tests for Five Different Cross Grades and Two Stubble Heights

No.	Dist., feet	Aver. Width, feet	Area, sq. ft.	Side Grade		Stubble height, inches	Straw (a)		Grain in Straw				Straw (d) per hour lb.
				Angle	Per Cent		Lb.	% above (b) 8-in. stubble	Oz. (e)	Lb. per acre	Bu. per acre	% (c) of yield	
1	50	8.66	433	0.0	0.0	18	17	61.4	1.75	11.0	0.18	0.6	2870
2	50	8.92	446	1.5	2.6	18	17	61.4	4.00	24.4	0.41	1.4	2870
3	50	9.76	488	3.0	5.2	18	16	57.8	31.00	173.4	2.89	9.6	2700
4	50	8.72	436	4.5	7.9	18	16	57.8	22.00	137.5	2.29	7.6	2700
5	50	9.50	475	6.0	10.5	18	17	61.4	47.50	272.1	4.54	15.1	2870
6	50	9.76	488	0.0	0.0	8	30	100.0	13.50	75.1	1.25	4.2	5070
7	50	9.00	450	3.0	5.2	8	28	100.0	60.50	366.5	6.11	20.4	4730
8	50	9.32	466	6.0	10.5	8	25	100.0	73.00	426.5	7.11	23.7	4220

(a) Height of wheat was 42 to 54 inches.
(b) The average of the weights of the straw in Tests 6, 7 and 8 was taken as 100 per cent in figuring the percentages for Tests 1 to 6 inclusive.
(c) Figured on the basis of a total yield of 30 bushels per acre.
(d) Figured on the basis of 1.6 miles per hour.
(e) Shown in Fig. 1.

Separating Efficiency of Prairie Type Combines on Cross Grades[1]

By E. G. McKibben[2]

GOOD threshermen have always insisted that grain threshers should be rather accurately leveled in order to obtain the maximum separation of grain from straw and chaff. Frequently prairie type combined harvester-threshers (those without leveling attachments) are operated on cross or side grades which would not be tolerated by even a careless operator of a stationary threshing machine. While there is always the possibility that under any given set of conditions the increased loss of grain in the straw caused by cross grades may not be great enough to justify the expense of a leveling attachment, there is considerable evidence that this question is worthy of careful and possibly rather extended investigation.

A limited investigation of this problem was made at Pennsylvania State College last summer (1930). Using a 12-foot combine with a leveling attachment, blanket tests were made when operating at an 18-inch stubble height and on 0, 2.5, 5, 7.5, and 10 per cent cross grades, respectively; and three tests when operating at an 8-inch stubble height and on 0, 5, and 10 per cent cross grades, respectively. (The desired cross grades were obtained by use of the leveling device.)

Table I (page 62, opposite) and Figs. 1 and 2 show the results of these trials. It should be noted that they were made in a field where the yield was between 30 and 35 bushels per acre and where most of the straw was at least 4 feet high. However, it is also well to remember that a 5 per cent grade is not a very steep grade and that many fields in most farming communities have grades this steep. Even 10 per cent grades are frequently found.

While the results of these trials should be considered as indicators or inferences rather than satisfactorily proven conclusions, there seems to be justification for the following inferences:

1. In tall heavy grain even small cross grades may cause an appreciable increase in the grain lost in the straw.
2. Decreasing the amount of straw handled materially decreases the undesirable effects of cross grades, and vice versa.

This last inference is further supported by the fact that trials at Iowa State College last fall (1930), with the same model of combine, while harvesting light to medium yields of soy beans, showed no significant correlation between the per cent of cross grade and separating efficiency. This was of course within reasonable limits, that is, cross grades up to 15 to 20 per cent. Of course at steeper cross grades, for example above about 15 per cent, other losses as at the side of the grain pan or under the grain carrier may be expected.

RELATION BETWEEN HEIGHT OF CUTTING AND AMOUNT OF STRAW HANDLED

In connection with the effect of handling increased amounts of straw it is interesting to note how much more straw must be handled when cutting a shorter stubble. Figs. 3 and 4 show the results of measurements and weighings of two samples from the Pennsylvania State College field in which the trials reported in Table I were made; these samples were taken, measured and weighed independently, one by the author and the other by C. O. Cromer, professor of agronomy at that institution. Note in Fig. 4 that about 30 per cent of the straw above the 8-inch height was found in the 10 inches between the 8 and the 18-inch height. The 8-inch height was taken as a base because that was the average of the approximate heights of binder stubble found in twenty-five fields near Pennsylvania State College.

It is well to keep in mind that only one of the many available models of combines was used in these trials. Comparative trials with other types, operating under similar conditions would be the only way to determine the relative suitability of the construction used in this machine for operating on cross grades. This emphasizes the need for further investigation.

LEVELING ATTACHMENTS

Of course in our enthusiasm for increasing the efficiency of separation, we must not forget that under a given set of harvesting and marketing conditions a given increase in separating efficiency will only finance a certain

[1]A report of a limited investigation of the problem stated in the title carried on at Pennsylvania State College by the author during the summer of 1930. Publication authorized by the Director of the Pennsylvania Agricultural Experiment Station as Technical Paper No. 515 of that station. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Associate professor of agricultural engineering at Iowa State College. Mem. ASAE.

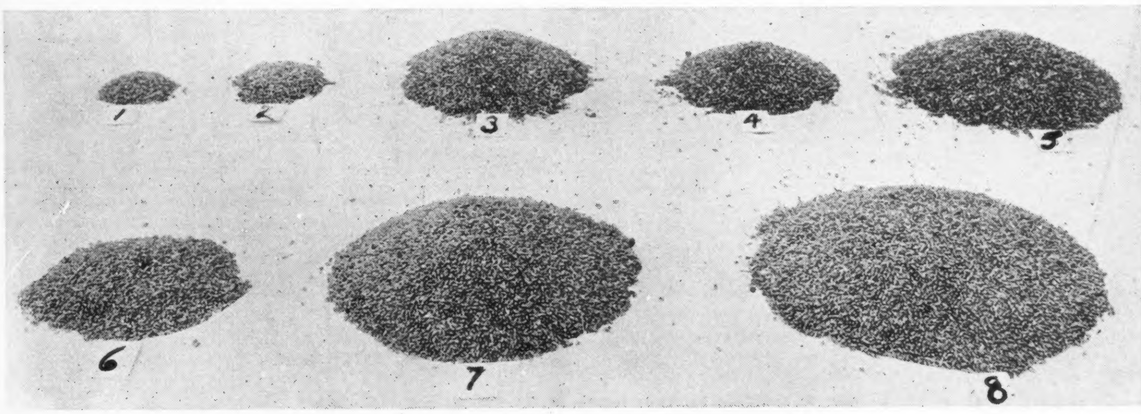
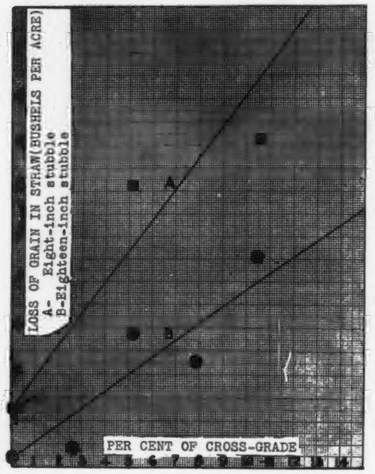
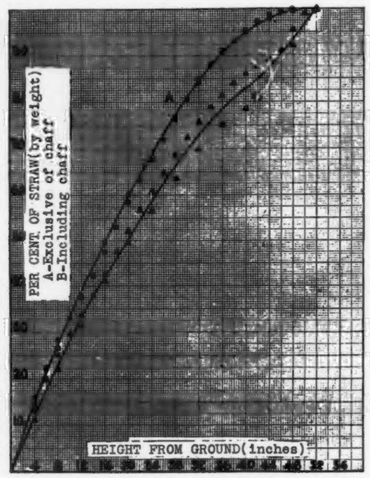


Fig. 1. Grain recovered from straw in the trials shown in Table I





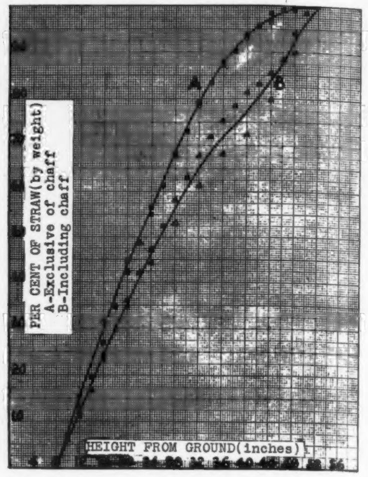


Fig. 2. (Left) Loss of grain in straw (bushels per acre) plotted against cross grade (per cent) for the eight trials shown in Table I. The curves are added to call attention to the rapid increase in losses as the cross grade increased. It is probable that under many conditions this is not a straight relationship. Certainly this limited number of trials with only one machine in one field cannot furnish enough data to determine the most probable shape of these curves, although there is enough to indicate the possibility, under certain conditions, of serious losses resulting from modern cross grades. Fig. 3. (Middle) Relation between height from ground and per cent of total straw weight found below the given height. Fig. 4. (Right) Relation between height from ground and per cent of total straw above an 8-inch height, found below the given height

increase in the first cost resulting from the addition of a leveling device. For example, if a leveling attachment added $150.00 to the first cost, and if 15 per cent is assumed to cover depreciation, interest, and repair, the added yearly cost would be $22.50. This would be approximately 23 cents per acre if 100 acres were harvested, or 11 cents per acre if 200 acres were harvested. Under these conditions a saving of one bushel per acre of almost any grain would pay the cost of use of the attachment and a saving of ¼ bushel might, or might not, depending on the market price. In this connection it should be noted that, for the conditions under which the trials shown in Table I were made, the loss caused by a 5 per cent cross grade was over 2 bushels per acre.

It is also of interest to note that, of fifty-one models manufactured by fifteen companies which were listed in the 1930 Cooperative Tractor Catalog, only eight are equipped with leveling attachments, and that these eight are made by four companies.

These limited trials also indicated that, if a leveling attachment is to be most effectively used, the controls must be conveniently located so that they can be operated by the header tender without leaving the header controls, and some method of indicating when the combine is level must be provided. Since this last requirement can be fulfilled by so simple a device as a properly designed and damped pendulum there seems little excuse for failure to meet these requirements. Under conditions where the grades are severe and changes in grade are frequent and abrupt, it is possible that an automatic leveling device, which would save more than its cost of installation, might be developed.

ESTIMATING LOSSES IN STRAW

While the practical combine service man and field operator is interested in losses in terms of bushels per acre, he is usually neither equipped nor trained to make complete and accurate tests, although this is not a difficult procedure. Also, the required time is usually not available. The result is that he usually fails to make even a careful estimate. However, it is comparatively easy to make such an estimate.

From the number of grains per bushel (any county agent, or the farm crops department of any agricultural college, should be able to furnish this figure for the grain being harvested) the number of square feet in an acre, and the width of cut, it is possible to figure the grains per foot of straw windrow for a loss of one bushel per acre. Table II gives these figures for several widths of cut and number of kernels per bushel. Thus by stopping the straw spreader and making a careful examination of the straw windrow and ground under, it is possible to judge whether or not the losses are serious. Failure to stop the straw spreader and make such an examination is probably one of the reasons why the increased losses caused by cross grades frequently go unnoticed.

CONCLUSION

The results of the limited trials reported, and of reports from other combine owners, seem to indicate the need of additional investigation of the following problems:

1. Effect of cross grades on separating efficiency in harvesting grains with heavy yields of straw
2. Effect of cross grades on losses at other points such as the sides of grain pans and conveyors
3. The development of a practical automatic leveling device for the combined harvester-thresher, or for certain parts of its separating mechanism
4. The reduction of the losses at present resulting from side grades by changes in or additions to the present separating mechanisms
5. The proper ratio between the threshing capacity of the cylinder and the straw-handling capacity of the separator for heavy yields of straw.

Table II. Grains per Foot of Travel for One Bushel per Acre

Width of cut (ft.)	Grains per Bushel			
	700,000	800,000	900,000	1,000,000
1	16	18	21	23
8	128	147	165	183
10	161	184	207	229
12	193	220	248	275
14	225	257	289	321
16	257	294	331	367
18	289	331	372	413
20	321	367	413	459

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Water-Power Resources of the Umpqua River and Its Tributaries, Oregon, B. E. Jones and H. T. Stearns (U. S. Geological Survey, Water-Supply Paper 636-F (1930), pp. VI + 221-330, pls. 11, figs. 23).—This report describes the water-power resources of the Umpqua River Basin, and outlines a plan for their development.

The total potential power of the Umpqua River Basin without storage is 243,000 horsepower for 90 per cent of the time and 573,000 horsepower for 50 per cent of the time. With storage the total potential power can be increased to 354,000 horsepower for 90 per cent of the time and 549,000 horsepower for 50 per cent of the time. With unified operation the power available 90 per cent of the time could be increased in an average year to more than 400,000 horsepower, of which 350,000 horsepower would be on the Umpqua and North Umpqua Rivers, 15,000 horsepower on the Clearwater River, and 9,000 horsepower on Mill Creek.

Surface Water Supply of St. Lawrence River Basin, 1926 (U. S. Geological Survey, Water-Supply Paper 624 (1930), pp. V + 163, fig. 1).—This report, prepared in cooperation with the states of Wisconsin, Illinois, Ohio and New York, presents the results of measurements of flow made on streams in this basin during the year ended September 30, 1926.

Rapid Transformation of Rocks into Arable Soil by the Use of Agricultural Explosives, A. Piedallu (Comtes Rendus des Seances de l'Academie d'Agriculture de France (Paris), 16 (1930), No. 7, pp. 247-250).—The results of two years' experiments on the pulverization of very compact calcareous sandy loam soils and calcareous rocks by the use of agricultural explosives are briefly summarized. Charges of from 1 to 3 cartridges containing from 100 to 125 grams of explosive each were placed at depths of from 1 to 1.5 meters and spaced 2 meters longitudinally and 1 meter laterally. The simultaneous explosion of 4 or 5 charges pulverized the soil and reduced the rocks to a grain size suitable for arable soil. With proper supplemental fertilization the production of satisfactory potato crops was possible. The conclusion is drawn that the natural infertility of such soils is due more to their compactness than to their composition.

[Irrigation Investigations at the California Station] (California Station (Berkeley) Report 1929, pp. 83-86).—S. H. Beckett found that mature orange groves in the vicinity of Santa Ana, Tustin and Anaheim have, under efficient irrigation practice and normal climatic conditions, a total seasonal irrigation requirement of 18 acre-inches per acre.

Beckett, H. F. Blaney and C. A. Taylor found that in the irrigated citrus groves, when the available moisture has been exhausted from the unirrigated portions of the soil, there is no apparent increase in the rate of water extraction from the irrigated portions; also, that there is some evidence that the quantity of water used by citrus trees is dependent upon the percentage of soil mass moistened by irrigation.

M. R. Huberty concluded that on the deep soils of light texture, three irrigations totaling 18 acre-inches in depth will be sufficient to meet the moisture requirements of the average orchards of the Sacramento Valley, while a seasonal depth of 24 inches will meet the demands of the large, vigorous growing orchards. The average orchard growing on the deep silt loam soil will require a total depth of about 18 inches applied in two irrigations.

In investigations of the effect of irrigation on canning and drying peaches F. J. Veihmeyer and A. H. Hendrickson found that no measureable differences were produced in the fruit unless the soil moisture was reduced to about the condition at which plants permanently wilted, a condition which is termed the "permanent wilting percentage."

Substantial evidence was obtained by C. F. Dunshee of the control of early maturing types of water grass by continuous submergence. A three-year study in the irrigation of cotton, conducted at Shafter, showed that where the crop is grown under soil-moisture conditions in which the plants are not allowed to wilt, the total seasonal transpiration use of water averages 30 acre-inches per acre, and that under careful irrigation practice a seasonal depth of 36 inches of irrigation water is required to meet this demand. The results of flower counts show that when the soil-moisture is reduced to about the permanent wilting percentage there is a marked effect on the number of flowers produced, as well as on the time the plants reach the peak of the flowering period. The period of maximum use of water was found to be during the peak of the flowering period.

Studies by Veihmeyer and J. P. Conrad of root development in relation to soil moisture showed that if the soil is wet at the beginning of the growing season to the full depth to which roots of the plants would normally penetrate, subsequent additions of water, unless adverse conditions of growth are brought about thereby, can have little influence on the extent of root development.

Flow of Water in Drainage Channels, C. E. Ramser (U. S. Department of Agriculture, Technical Bulletin 129 (1929), pp. 102, pls. 31, figs. 20).—This bulletin is a revision of and supersedes Department Bulletin 832. It reports the results of experiments to determine the roughness coefficient **n** in Kutter's formula, as applied to open channels, which were conducted in nine different localities, namely, Lee, Washington and Bolivar Counties, Miss., western Tennessee, western Iowa, southern North Carolina, eastern Florida, eastern Arkansas, southeastern Missouri, and central Illinois.

The results indicated that a deposit of slick slimy silt on the sides and bottom of a channel greatly reduces frictional resistance to flow, and that the clearing of perennial growth from a channel will greatly increase its capacity. The growth of grass and weeds in a channel during the summer and the accumulation of drift, trees, logs and other obstructions greatly decrease its capacity. After a certain amount of erosion has taken place in a channel, further erosion does not necessarily increase the roughness of the perimeter.

The results further indicate that the roughness coefficient **n** is appreciably higher for a roughly dredged channel than for a smoothly dredged one, and that ordinarily a dredged channel quickly deteriorates in hydraulic efficiency unless systematically maintained. Abrupt variations in cross section were found also to be important factors in reducing the hydraulic efficiency of a channel.

The following values of the roughness coefficient **n** in Kutter's formula are recommended for use in computing the capacity of drainage channels of the conditions described: Large channel in rolling country, with high velocity and sufficient low water flow to prevent rapid growth of vegetation, slick silt lining perimeter, maintenance, 0.025; large channel in rolling country, with sufficient low water flow to prevent rapid growth of vegetation; moderate erosion, maintenance, 0.03; large channel in flat country, with fairly large low water flow, no appreciable erosion, annual clearing, 0.03; small channel in rolling country, with small low water flow, erosion sufficient to cause some irregularities, maintenance, 0.035; small channel in flat country, with insufficient low water flow to prevent rapid growth of vegetation in lower part of channel, annual clearing, 0.035; large channel with high velocity and large low water flow, rapid erosion causing large irregularities, no vegetation, 0.035; and small channel in flat country, with very fertile loamy soil conducive to rapid growth of vegetation, very small low water flow or dry in summer, annual clearing, 0.04.

The Duty of Water for Rice Irrigation on the Grand Prairie of Arkansas, B. S. Clayton (Rice Journal (New Orleans) 33 (1930), No. 2, pp. 18, 24, 25).—This is a contribution from the division of agricultural engineering of the U.S.D.A. Bureau of Public Roads, dealing with investigations made in cooperation with the Arkansas Experiment Station relating to the duty of water for rice irrigation.

The data presented indicate that from 24 to 30 inches of water are required to raise a crop of rice, depending in each case on the proportion of early and late varieties and also to some extent on the number of continuous seasons that the fields have been planted to rice. Continuous planting encourages the growth of water grasses, which in turn make necessary a greater depth of water to check their growth.

The conclusion is also drawn that a well should have a capacity of from 5 to 6 gallons per minute for each acre irrigated, depending on the variety of rice and the condition of the land. Where the land is rather level, the subsoil impervious, and the water used in an economical manner, a well capacity of 5 gallons per minute will suffice.

With reference to the possibility of storing surface waters in reservoirs for rice irrigation, the data suggests that a storage of 2 acre-feet for each acre irrigated will be adequate.

Suspended Matter in the Colorado River in 1925-1928, C. S. Howard (U. S. Geological Survey, Water-Supply Paper 636-B (1929), pp. II—15-44, pl. 1, figs. 2).—The results of this investigation indicate that the annual load of suspended matter in the Colorado River computed from samples collected at Grand Canyon was considerably larger than the average annual load computed from samples collected at Yuma. It was also found

that for a considerable portion of the material a given weight will occupy a larger volume than has been assumed in recent estimates. For these reasons it is concluded that possibly some of the previous estimates of the volume of material that would be deposited in a reservoir have been too low.

Drain-Line Spacing in the Drainage of Mineral Soils, Rothe (Kulturtechniker (Berlin), 32 (1929), No. 2, pp. 155-169, figs. 3).—A summary is presented of the available data relating to drain spacing, and an analysis is made with particular reference to the requirements of mineral soils in northern Germany, some experimental results being reported. It is recommended that in northern Germany drain-line spacing for drainage at a depth of 1.25 meters be determined according to the formula $E = (117 \div W) = (638 \div W_e)$, in which W is the hygroscopicity of the soil and W_e is the percentage of settleable particles.

Geology and Ground-Water Resources of North Dakota, H. E. Simpson (U. S. Geological Survey, Water-Supply Paper 598 (1929), pp. V + 312, pls. 3, figs. 10).—This report, prepared in cooperation with the State Geological Survey of North Dakota, deals with the physiography, climate, water-bearing formations, and artesian water resources of North Dakota, special attention being devoted to its use for public water systems. An article on the "Quality of the Waters of North Dakota," by H. B. Riffenburg, is included.

Upper Colorado River and Its Utilization, R. Follansbee (U. S. Geological Survey, Water-Supply Paper 617 (1929), pp. XV + 394, pls. 13, figs. 5).—This report includes a preface by N. C. Grover, and presents in form for ready reference the available data pertaining to the present and future utilization of the surface waters of the upper Colorado River Basin, above the Green River, together with information relating to topography, climate, evaporation, water supply, trans-mountain diversions, storage, irrigation and agriculture, and water power as they existed in 1927.

Surface Water Supply of North Atlantic Slope Drainage Basins, 1925 (U. S. Geological Survey, Water-Supply Paper 601 (1930), pp. VI + 269, fig. 1).—This report, prepared in cooperation with the states of Maine, New Hampshire, Massachusetts, New York, New Jersey, Maryland and Virginia, presents the results of measurements of flow made on streams in the north Atlantic slope drainage basins during the year ended September 30, 1925.

Surface Water Supply of Pacific Slope Basins in Southern California, 1894-1927, H. D. McGlashan (U. S. Geological Survey, Water-Supply Paper 636-E (1930), pp. VI + 169-219).—This report prepared in cooperation with the state of California presents a summary of the records of flow measurements made on streams in the Pacific slope basins in southern California during the period from 1894 to 1927.

Surface Water Supply of Ohio River Basin, 1925 (U. S. Geological Survey, Water-Supply Paper 603 (1929), pp. VII — 343, fig. 1).—This report, prepared in cooperation with the states of New York, West Virginia, Ohio, Virginia, Illinois, Tennessee, North Carolina and Alabama, presents the results of measurements of flow made on streams in this basin during the year ended September 30, 1925.

Surface Water Supply of the San Joaquin River Basin, California, 1895-1927, H. D. McGlashan (U. S. Geological Survey, Water-Supply Paper 636-D (1930), pp. VI + 101-168).—A summary is presented of the records of flow measurements made in cooperation with the state of California on streams in the San Joaquin River Basin of California from 1895 to 1927.

Electrical Soil Heating, W. Kind (Technik Landwirtschaft (Berlin) 10 (1929), No. 12, pp. 285-290, figs. 9).—German practice in the heating of the soil of hotbeds by electricity is described and illustrated.

It has been found that with an outside temperature in the neighborhood of freezing a hotbed will require approximately 1 kilowatt-hour of electricity per 24 hours per square meter of soil for the average run of hotbed crops. Special rates are available for night heating from 10:00 p.m. until 6:00 a.m. The night use of electricity for this purpose has been found to vary from 100 to 150 watts per hour per square meter of soil.

Knotty Lumber for Boxes, G. E. Heck and I. B. Lanpher (U. S. Department of Agriculture Circular 105 (1930), pp. 20, figs. 15).—This circular presents the results of special tests made at the Forest Products Laboratory to determine the effect of knots in certain box parts, and to show how knotty lumber can be used in boxes without decreasing the serviceability of the container. Recommendations regarding the size and position of knots in the several parts of wooden boxes are given which are based not only on the tests presented but on extensive experience in tests of boxes and other wooden products and on observation of containers in service.

Static bending, impact bending and compression parallel to the grain tests made to determine the effect of knots on the strength of second-growth northern white pine box lumber showed that the size of the knot or of the knot hole represents the portion of the width of the board rendered ineffective in resisting cross-breaking stress. It was found that the shock-resisting capacity of the board is reduced by a knot to a greater extent than is the resistance to cross-breaking stress, and that the stiffness of the board is less affected by knots than is the cross-breaking strength. It was also found that the shape of the knot, that is, whether round, oval, or spike, and whether it is intergrown or incased are not important factors in the strength of the board, and that the position of the knot is of no great importance, provided it does not occur in the nailing edge.

It was found that knots reduce the cross-breaking strength of a board. However, if the sides, tops, and bottoms of boxes are of sufficient thickness to resist shearing at the nails, knotty boards may be used without causing cross-breaking failures. If the knots are large enough the cross-breaking strength of the box board is reduced below the strength of the nailing. Failures by breaking across grain then predominate, and the amount of rough handling the box will withstand is less on the average than if the full strength of the nailing is utilized. Ordinarily, it is preferable to have nail failures in a box rather than to have the box boards break across grain. Knots large enough to consistently cause cross-breaking failures should, therefore, be avoided. With knot diameters of about one-fourth the width of the boards there were very few failures as a result of the boards cross breaking at the knots in either the boxes of 4 or 5-nailed construction. With knot diameters of one-third the width of the boards, more than one-half of the boxes of four-nailed construction with ⅜-inch (thin) sides, tops and bottoms failed by cross breaking at the knots, and in the boxes with ½-inch (thin) sides, tops and bottoms failures at the nails predominated. It appeared advisable to limit knot diameters to about one-fourth the width of boards that have slenderness ratios greater than 60.

The tests showed that knots of equal size have equal influence on the strength of the box regardless of the shape of the knots, that is, whether they are round, oval, or spike.

The test results showed little difference in the relative effect of intergrown and incased knots or of knot holes on the strength of boxes.

Metal bindings were found to modify the effect of knots on the strength and serviceability of boxes in a favorable manner.

Rainfall Characteristics and Their Relation to Soils and Run-Off, C. S. Jarvis (American Society of Civil Engineers (New York) Proceedings 56 (1930), No. 1 pt. 1, pp. 3-47, figs. 7).—This article summarizes "information regarding precipitation and its occurrence in various countries and latitudes; its relation to soils and run-off; the vegetative, topographic and physiographic features of the watersheds; and the resultant influence on designs of drainage structures and channels."

Precipitation records for the principal stations throughout the world are assembled in a table showing averages and observed variations. The sources of the data are cited.

Progress Report on Draft of Plows Used for Corn Borer Control, W. Ashby (U. S. Department of Agriculture, Bureau of Public Roads [1930], pp. 33, pls. 2, figs. 4).—This is a preliminary report of experiments which included a series of tests with 22 standard plows at 6-inch and 21 at 8-inch depths on clay loam soil, tests of 10 standard plows at 6-inch depth at speeds of 2.5 and 3.25 miles per hour, tests of a convertible one to three-bottom plow, tests of various plow attachments, and miscellaneous tests of small groups of plows.

Variations in soil resistance affected the draft of plows tested more than any other factor. Draft ranged from less than 5 pounds per square inch of furrow slice on sandy loam soil in good working condition to 15 pounds per square inch of furrow slice on dry clay loam. In one field of clay loam soil average draft varied from 9 pounds per square inch when the soil was moist to 15 pounds per square inch when very dry. Packing of the soil by tractor wheels increased the draft on moist soils to a marked extent. Disking and rolling before plowing increased the draft on moist soils but not on dry soils.

The average plow with a rear wheel giving full support apparently pulled 7 per cent easier than a similar plow with no rear wheel when other factors were held constant. Drawbar pull due to weight of plow was apparently 18.5 pounds for each 100 pounds of weight. Plows with high slope coefficient or wide, low wing of mold pulled somewhat heavier than those with opposite characteristics when other factors were constant. These qualities are associated with good coverage and indicate that good covering ability usually is accompanied by a moderate increase in draft. Width of waist, another index of covering ability, did not appear to affect draft.

On clay loam soil, which had been plowed to a depth of more than 8 inches for several years, draft did not increase in proportion to depth of plowing. Drawbar pull at 8-inch depth averaged only 15 per cent more than at 6-inch depth. When the plow penetrated below the old plow sole results were very erratic. Average draft of 10 plows increased 8.6 per cent with increase of speed from 2.5 to 3.25 miles per hour. Coulter, jointer, and covering wires seem to absorb between 10 and 15 per cent of the total power required to draw the plow.

The data and analysis indicate clearly that packing by machinery was a major factor in the draft of plows in this series of tests, since total draft increased by 10.5 per cent as the proportion of plowed earth packed by the tractor wheel increased from 32 to 72 per cent, with other factors held con-

stant. An increase in weight of plow from 3 pounds per square inch of furrow slice to 5 pounds per square inch increased the draft by 3.5 per cent.

Geology and Water Resources of the Mokelumne Area, California, H. T. Stearns, T. W. Robinson, and G. H. Taylor, (U. S. Geological Survey, Water-Supply Paper 619 (1930), pp. XII + 402, pls. 21, figs. 33).—This report presents the progress results of an investigation of the geology and water resources of an area of approximately 615 square miles lying about 25 miles south of Sacramento in California.

The report includes all the available records of the surface water of the area. The principal streams are the Mokelumne River, Dry Creek and Bear Creek. Only the Mokelumne River is perennial, and its average annual run-off is about 800,000 acre-feet. Records of all diversions from the Mokelumne River are given, including detailed descriptions of 57 pumping plants and the crops irrigated by them. These plants divert about 3,500 acre-feet per annum. In addition, the Woodbridge Canal diverts about 35,000 acre-feet for irrigation of the Woodbridge irrigation district.

A record of 2,001 irrigation pumping plants on wells, including the area and kinds of crops irrigated, is given. The area irrigated by the use of ground water has progressively increased from 4,300 acres in 1909 to 45,800 acres in 1927. Tests on the use of water by 53 pumping plants on wells for the principal crops of the area are described in detail. The average use of water on orchard and vineyard land, exclusive of precipitation, was found to be about 1.3 acre-feet per acre per year, and for alfalfa and miscellaneous garden crops about 3 acre-feet per acre. From these figures it was computed that 64,800 acre-feet is pumped annually from the ground for irrigation. In addition, about 6,000 acre-feet is pumped for domestic use and stock.

Tests of specific yield were made on undisturbed soil columns and are described in detail. They indicate a specific yield of less than 25 per cent for the water-bearing material. The principal aquifers are the arkosic sand strata of the younger alluvium. Good irrigation supplies are generally obtained at depths between 100 and 200 feet, and domestic supplies at less than 100 feet.

Grain Drying by Forced Draft with Heated Air, W. M. Hurst and R. C. Miller (U. S. Department of Agriculture, Bureau of Public Roads, 1929, pp. 10, pls. 2).—Studies conducted in cooperation with the North Dakota Experiment Station are reported.

The results showed that wheat, oats, barley, rye and buckwheat can be dried by forced draft with heated air but that considerable time is required for the process. The exact time required depends in part upon the air conditions and the initial moisture content of the grain. Under the most favorable drying conditions secured, 40 to 60 minutes were required to reduce the moisture content of wheat from 18 to 14 per cent. Similar results were obtained in drying barley, rye and buckwheat, but oats required considerably less time to dry than any of the other grains.

The number of heat units supplied in drying the different crops seemed to depend largely upon the quantity of water evaporated. Regardless of the kind of grain or the initial moisture content, there appears to be no great difference in the average number of heat units supplied per pound of water evaporated under test conditions.

With coal at $12 per ton, the equivalent cost of fuel per bushel of grain dried was approximately 1.6 cents for wheat, 0.7 cent for oats, 1.7 cents for barley, 1.3 cents for rye, and 1.5 cents for buckwheat on the assumption that 50 per cent of the potential heat units are utilized from coal with a heat value of 12,000 Btu. per pound. The net increase in market value of three lots of wheat, due to the increase in test weight and decrease in moisture content, approximate 11, 17 and 16 cents per bushel, respectively.

The rate of drying or the temperature of the drying air seemed to have little effect on the weight per bushel of the grain at any given moisture content. The weight per bushel of artificially dried grain was practically the same as samples of the same grain dried under atmospheric conditions.

Artificial drying by forced draft with air at 120, 140, and 160 F did not seem to affect the germination of the grain nor were the milling and baking qualities of wheat impaired.

Electric Laundry Equipment on the Farm, W. T. Ackerman (New Hampshire Station (Durham) Circular 34 (1930), pp. 15, figs. 3).—Data on the electric laundry equipment on the seven experimental farms of the New Hampshire rural electrification project are summarized.

Washing machines consumed an average of 0.6 kilowatt-hour per week, 2.45 kilowatt-hours per month, and 30 kilowatt-hours per year. The corresponding average operating costs were 6 cents, 24⅓ cents, and $2.94. Depreciation costs on washers were estimated to exceed current consumption costs in the ratio of 85 to 15 per cent. Depreciation and current charges produce a cost of 41 cents per week, $1.75 per month, and $21 per year for the farm washing. Washing machines produced an average of 0.75 per cent of the total electric load per year, and 1 per cent of the expenditure for current.

The current used by flat irons average 1.6 kilowatt-hours per week, 6.8 kilowatt-hours per month, and 83 kilowatt-hours per year. The corresponding average operating costs were seven cents, 27 cents, and $3.28. Flat irons were responsible for 1.6 per cent of the total annual electric load, and for 2 per cent of the total expenditure for current.

Ironing machines were found to use an average of 2.1 kilowatt-hours of electricity per week, 9.1 kilowatt-hours per month, and 109 kilowatt-hours per year, with corresponding current costs of 9 cents, 38 cents, and $4.51. Depreciation costs were estimated to exceed current costs about 3 to 1 on this appliance. Ironing machines practically eliminate the use of hand irons where the two are used together, for the reason that the larger machine will do more work in one-third to one-half the time and with less fatigue. The agricultural trend or the formation of peak load during the summer season was evident with washing machines and flat irons, but not distinguishable in the load curves of ironers.

[Agricultural Engineering Investigations at the Missouri Station], J. C. Wooley et al. (Missouri Station (Columbia) Bulletin 285 (1930), pp. 36-41, figs. 4).—Experiments by Wooley and E. G. Johnson on the value of insulating board when used in the Missouri type poultry house showed that the lining appeared to affect the temperature very little. Presumably the insulating value of the lining was offset by the open front.

Tests by Wooley of the value of different varieties of wood for fence posts showed that variety is of more importance than treatment. Tests of preservative treatments showed that hot carbolineum is more effective than hot creosote when painted on. In the tank treatment with creosote the posts were submerged in hot creosote to a depth of about 30 inches for a period of 2 hours. They were then removed and plunged into cold creosote as quickly as possible. The condensation of the gases in the pores of the wood resulted in a much better penetration of cresote than otherwise would have been obtained. The 2-hour treatment resulted in an increase in the life of the fence post from 50 to over 300 per cent, depending upon the variety. It is not advisable to use a post which will not last more than 10 years. This eliminates most of the so-called soft wood varieties. An inspection of the posts treated by steeping with zinc chloride and with sodium fluoride did not reveal any failures to date. The specimens of lumber treated by this process did not show sufficient decay to indicate the value of the treatment.

Data also are reported on combine harvesters, the design of poultry houses and cribs and granaries, tile drainage, and the use of electricity on Missouri farms.

[Drainage Studies at the Florida Station] (Florida Station (Gainesville) Report 1929, p. 95).—In connection with investigations on the movement of underground water, studies on the establishment and deportment of mole lines or formed lines of seepage showed "that the mole principle might be made an unusually effective and economical agent in the solution of one of our most important problems, namely, a closer manipulation of the water table in organic soils under conditions of cultivation."

[Irrigation Investigations at the Colorado Station], R. L. Parshall (Colorado Station (Fort Collins) Report 1929, pp. 64-67).—Progress data are briefly summarized from studies of pumping, water measurement, water evaporation and meteorology.

Measurements made on a 20-foot reinforced-concrete improved Venturi flume show very close agreement with the law of discharge. For submerged-flow conditions on this flume, tests indicate a marked consistency in the relation to the computed discharge.

Book Review

"Land Drainage and Flood Protection" by Bernard A. Etcheverry, professor of irrigation and drainage, University of California, is a new text on the subject intended primarily for a college course in drainage but also planned for reference use by engineers, reclamation district officials and commissioners of assessment. It deals with soil formation, soil texture, soil water, harmful effects of lack of drainage, effects of drainage, natural drainage, required depth of drainage, volume of drainage water, general operations for the drainage of large areas and drainage by open channels, underdrainage, special cases of drainage problems, properties of drain tile, construction and maintenance of tile drains, drainage of water-logged irrigated lands, protection of lands from flood waters, computation of flow in river channels, reclamation of tidal lands, and drainage and reclamation districts. McGraw-Hill. $3.00.

"Light Frame House Construction" is published as U.S.D.C. Bulletin No. 145, Trade and Industrial Series No. 41. It is issued by the Federal Board for Vocational Education, in cooperation with the National Committee on Wood Utilization, and contains technical information for the use of apprentice and journeyman carpenters. Superintendent of Documents, Washington, D. C., 40 cents.

AGRICULTURAL ENGINEERING

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

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RAYMOND OLNEY, Editor

R. A. Palmer, Assistant Editor

The New Bureau

REJOICE! At last provision for a Bureau of Agricultural Engineering in the U. S. Department of Agriculture is practically completed.

The original appropriation for the Bureau, approximately one-half million dollars, may not be large enough to fully satisfy everyone. It is almost certain that some interests will feel slighted in the detailed specification that these funds shall be spent so much for this and so much for that. But how closely the original appropriation approximates the technical ideal in the amount of funds provided and the uses to which they may be put is relatively immaterial at this time.

What is important is that the agricultural engineering profession has been given increased recognition, opportunity and responsibilities which it has been seeking for more than a decade. It will be watched sharply by its critics to see whether or not the benefits to agriculture to come from this increased support materialize as promised. It will be severely criticised for the painful agricultural readjustments it will accelerate. But its principles; its leadership; its outlook are all to the good. With diligence it should be able to justify the Bureau of Agricultural Engineering in spite of unfair criticism. We predict that it will.

Engineering and the Business Depression

DOWN through the ages men far ahead of their times in intellect and action have been misunderstood, feared and punished. The world has dealt harshly with its leaders. Bravely they have made their contributions and sipped their reward of poison oak. As the slow world has caught up with each, generations later, it has written his name in gold on the long and honored list of martyrs to progress.

Human nature has changed little. Public opinion is the poison oak of today and the engineering profession sits in the chair of the accused, charged with the present economic depression.

There is a hollow ring in the voice of its accusers. While loudly denouncing the engineering profession, they have still not forsaken the advantages engineering has given them. They have not yet gone back to the tallow candle, the horse and buggy, the twelve to sixteen-hour day and the subsistence living of pre-engineering days.

Furthermore, they are comparing present conditions not with depressions of the past, or even with peak periods of the past, but with the all-time record high level of prosperity reached in 1929. The engineering profession is guilty of the present depression to the extent that it made possible the high level of prosperity immediately preceding, and may well be proud of the fact.

But, to apply a war-born phrase, "A good offense is the best defence." As long as engineering occupies the prominent position it does today it will be accused of every condition and circumstance which makes this world less than utopian. Engineers can best answer their accusers by continuing diligently at their infinite task of eliminating and overcoming conditions which are obstacles to human advancement; by holding to scientific truth, unmoved by public clamor; by being, if necessary, willing martyrs to progress.

A Farmer and Laborer's Viewpoint

SCHOLARLY economists, humanly interested sociologists, politicians high and low, scientific agriculturists, dirt farmers, machine-minded engineers and hard-headed business men have in recent years been building up a considerable volume of testimony, pro and con, on the subject of large-scale and corporation farming.

To this varied array of theories and conclusions the Sacramento (California) "Bee" recently added the humble, unsolicited opinion of a former farmer. The interesting and valuable viewpoint reflected is the product of thirty years of farming experience both in Missouri and California, and a few years of experience as a laborer. This man and his wife, according to his testimony, worked hard for thirty years with advantages and opportunities, trials and tribulations similar to those of many other farmers. But his limited means left him fighting with muscle, conditions which are beyond the control of man's motive power. He was finally unable to make a go of it.

Now he is working as a laborer, eight hours per day at 50 cents per hour. He and his wife are saving a little, enjoying their home life more than ever before and resting from their thirty strenuous years on the treadmill of marginal production. From his first-hand knowledge of the conditions and problems with which the individual farmer has to cope, he looks with optimism upon the trend toward corporation farming and gives expression to his outlook in part as follows:

> ". . . . . The modern trend is toward mergers and elimination of overhead by consolidation. It is the only sensible remedy.
>
> "It has proven itself in other lines of individual endeavor and will prove itself in farming. Every advance step has been fought since history began. The first reapers and harvesters and threshers and tractors were fought, but who would go back to the conditions which preceded them? In the days of home workshops and all hand work we had none of the modern comforts such as electric lights, automobiles, telephones and radios. If those conditions obtained today, we would still be stumbling along working a 12 or 16-hour day for 10 or 15 cents an hour. The corporation owned and operated farm, with fences and boundaries obliterated, is coming fast, certainly and surely, and when it is an actual fact, we will wonder why we did not have sense enough to establish it sooner."

Kettering on Ideas

"THE engineer has been in a strait-jacket for the last ten years and I am wondering whether now, since he has had some liberties with his hands and perhaps with his head, he can take his old warped slide rule and really go out and figure something new. I am wondering whether or not his imagination has not been thwarted somewhat, but I am telling you today that an idea is worth money, and we ought to have as many ideas now as we ever had."—C. F. Kettering, president of the General Motors Research Corporation, to the A.S.A.E. at its recent annual meeting.

A. S. A. E. and Related Activities

Anniversary Meeting Plans Revealed

CONSIDERING needs, demands, the merits and demerits of similar structures, special requirements to be met and materials available; planning, drafting, studying, revising and redrafting; with before their eyes the mirage of the completed structure, H. B. Roe and his Meetings Committee have been for weeks quietly going about the preliminary work of building the program for the 25th annual meeting of the American Society of Agricultural Engineers, to be held at Ames, Iowa, June 22 to 25. They have the foundation sunk to bed rock and have raised the framework.

The general plan calls for opening on Monday morning with simultaneous technical division meetings which will carry over to Tuesday morning; holding a half day meeting of the College Division Tuesday afternoon; celebrating "Anniversary Day" Wednesday; reserving the evenings for the annual dinner, annual business meeting and special group meetings; sandwiching in a few demonstrations, tests, visiting hours, side trips and other features; and closing with general sessions on Thursday. Opportunity for technical sessions by the technical divisions is being provided in response to strong demand from these groups. They have been scheduled on the first days on the theory that they will serve to start the meeting off with a "bang" and that they require the deepest concentration. It is believed that after two full days of division, business and special group meetings everyone will be ready for the somewhat lighter features of greater general and inspirational interest scheduled for the third and fourth days.

"Anniversary Day," Wednesday, June 24, is to be celebrated by the address of welcome, the president's annual address, and several other addresses by prominent and specially qualified speakers who will look into the past, present and future of agricultural engineering; by a pageant envisioning agricultural engineering progress; and by the annual dinner of the Society.

A Council meeting, student members meeting, continuation of afternoon technical division sessions where desired, and committee meetings to be held are slated for Monday evening. The annual business meeting of the Society will come on Tuesday evening.

Some talented members of the Society which it has not recently had the opportunity of hearing, as well as some new drawing cards from other branches of engineering and education, have been tentatively scheduled for the general sessions on Thursday.

Further announcements will be made as details of the program are developed.

New Professional Course Announced

WITH THE new school year beginning in September, 1931, Clemson Agricultural College (South Carolina) will have a new professional course, leading to the degree of bachelor of science in agricultural engineering.

The course will be offered by a newly organized division of agricultural engineering. Heretofore the agricultural engineering work of the institution has been carried on under the administration of the agronomy division.

D. W. Teare, associate professor of agricultural engineering at the South Carolina school, drew up the new curriculum. It has been approved by the directors of both the engineering and agricultural divisions and announced in a recent catalogue of the institution, but has not yet been published.

Southeastern Section Presents Program at Atlanta

MEETING in conjunction with the Southern Association of Agricultural Workers, as has been its custom for the past several years, the Southeastern Section of the American Society of Agricultural Engineers presented its annual technical program in three successive afternoon sessions on February 4, 5 and 6.

Technical subjects scheduled for the first afternoon session included "Progress in Rural Electrification," "Solar Heating," "Heating and Ventilating Sweet Potato Houses," and "Agricultural Explosives." E. C. Easter, A. Carnes, H. E. Lacy and L. C. Le Bron, respectively, were the agricultural engineers to present these subjects. Also included in this first session were addresses on "The Place of the Agricultural Engineer in the Present Agricultural Situation," by L. J. Fletcher, agricultural engineer, Caterpillar Tractor Company, and "Cooperative Projects in Vocational Education," by R. H. Driftmier, head of the department of agricultural engineering, University of Georgia.

R. W. Trullinger, senior agricultural engineer, U.S.D.A. Office of Experiment Stations, and president of A.S.A.E., was the opening attraction of the program for the second afternoon. His subject was "Possibilities of Agricultural Engineering Research in the Southeast." Other topics and speakers of the session were "Farm Refrigeration" by V. C. Smith, "Mechanical Refrigeration for Pork Curing" by Fred L. Tunis, "Power Survey" by O. E. Hughes, agricultural engineer, University of Georgia, and "Irrigation and Water Supply" by Forrest D. Banning, agricultural engineer, Florida Power and Light Company.

"Cotton Costs" by J. T. McAlister, extension agricultural engineer, Clemson Agricultural College and "Cotton

The group caught by the cameraman, at the Reclamation Division banquet in San Francisco, January 6

Production Machinery" by John W. Randolph, agricultural engineer, U.S. D.A., were the only strictly cotton papers on the program. Other subjects and speakers of the closing session were "Fertilizer Placement Studies" by G. A. Cumings, agricultural engineer U.S.D.A., "Terraces" by A. F. Whitfield, president, Clover Fork Coal Company, and "Water Supply Campaigns" by G. I. Johnson, extension agricultural engineer, University of Georgia.

American Engineering Council

REPRESENTATIVES in the assembly of American Engineering Council gathered in Washington January 15 to 17 for their annual meeting which was held at the Mayflower Hotel on those dates.

R. W. Trullinger, president of ASAE and its representative in the Council assembly was elected by that body to membership on the administrative Board, which conducts most of the business of the organization.

The Annual Dinner held Friday evening, January 16, was attended by 200 engineers and government officials. Dr. George Otis Smith, chairman of the Federal Power Commission, spoke on the subject "Words, Facts and the Truth." Dr. Smith closed his address with these remarks:

"The engineer's attitude toward the truth is obvious: he is the accredited advocate for the truth. The mastery over the forces of nature that has been given to man by engineering has been won not so much by occasional flashes of spectacular genius as by the long-continued piling up of facts. Science, with its urge to know why, and engineering with its urge to know how, have together contributed in generous measure to human progress. And this spread of scientific research and of engineering practice has been nothing more and nothing less than the spread of the truth. It is the truth that makes us free—there is no other route, and thanks to his type of training, to his mode of thought, and above all, to his professional ideals, it is the engineer who surveys that pathway. To him words are of only passing interest; to him facts are guiding landmarks; to him the truth is the goal."

Major General Lytle Brown, Chief of Engineers, spoke upon the subject "Engineers, Builders and Executives." In concluding, General Brown said:

"I wish the American Engineering Council Godspeed. I take its mission to be the promotion of public interest, so far as the engineers of the country banded together can promote that interest. To promote the public interest, any agency devoted to that must be free from private interest, free from entangling alliances, free from rancor. It must be no hair splitter, but just and right in the largest sense. With these things in view, I assure the Council the whole-hearted support of the Corps of Engineers of the United States Army, which is devoted solely to the public service."

American Engineering Council believes that the facts and information bearing upon the balancing of the forces of consumption, production and distribution should be integrated, and hopes that some competent agency will undertake this work for the purpose of indicating what methods and organizations may be designed to bring about a controlled balance between these forces.

The Assembly voted to authorize the Administrative Board, and through it the Executive Committee, to take such steps as may be deemed advisable to carry out these recommendations, and if and when the necessary funds are provided, to take such steps as may be desirable to bring about such measures as are recommended therein.

Personals of ASAE. Members

Lawrence C. Moore has been appointed agricultural engineer of the Portland General Electric Company, Portland, Oregon, having recently completed graduate work for a master's degree in agricultural engineering, specializing in rural electrification, at Michigan State College.

Stanley F. Morse, consulting agricultural engineer, is spending six to nine months in Europe. In addition to inspecting a tract of land of 150,000 acres near Seville, Spain, he is studying agricultural conditions in England, France and Spain. He writes that the agricultural depression, including that of business in general, appears to be world wide, although France, Spain and Italy do not seem to have been so hard hit as other countries.

New ASAE. Members

Henry J. Barre, teaching fellow, Iowa State College, Ames, Ia.

William Harrigan, supervisor, manufacturers service, The Texas Company, New York, N. Y.

Thomas N. Jones, fellow in agricultural engineering, Alabama Polytechnic Institute, Auburn, Ala.

Arthur B. Kennerly, farm manager, Cartwright Ranch, Dinero, Tex.

Kirk M. Reid, illuminating engineer, General Electric Company, Cleveland, O.

George Valentine, vice-president, Massey-Harris Company, Ltd., Toronto, Ontario, Canada.

Robert A. Work, assistant irrigation engineer, U. S. Department of agriculture, Medford, Ore.

Transfer of Grades

Harry Hummel, farmer manager, E. C. Smith Dixboro Farms, Ann Arbor, Mich. (Junior to Associate Member.)

Harold D. Lewis, associate in agricultural engineering, University Farm, Davis, Calif. (Associate Member to Member.)

Russel L. Perry, assistant professor, University Farm, Davis, Calif. (Junior to Associate Member.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the January issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Arthur King, extension specialist in soils, Oregon State College, Corvallis, Ore.

Macy H. Lapham, senior soil scientist, U. S. Department of Agriculture, Berkeley, Calif.

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is on charge for this service.

Men Available

AGRICULTURAL ENGINEER, degree from Ohio 1924. Associate member of American Society of Agricultural Engineers, one year with barn equipment company as draftsman and salesman, three years drainage specialist in middle western states, two and one-half years county agricultural agent, experienced in handling power machinery and equipment, organizing and handling labor, two years mechanic in United States army, desires permanent employment as extension engineer, position with a farm machinery company or agricultural enterprise. Willing to go anywhere; 33 years old, married, two children. MA-187.

RURAL ELECTRIFICATION ENGINEER, with degree from a state university, now employed as rural electrification engineer by a public utility in the Middle West, desires a change of location. Experience as county farm adviser and three years experience in rural electrification. Would be interested in college or experimental station research work in rural electrification or as rural electrification engineer with public utility. MA-193.

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